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User's Guide for SEALOADS version 1.1: A Computer Program for Prediction of Nonlinear Ship Motions, Sea Loads, and Pressure Distribution in the Time Domain

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Contract #W7707-008063/001/HAL

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Defence R&D Canada

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October 2001



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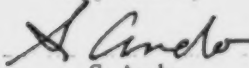
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Authors

W. Qiu, H. Peng, and C.C. Hsiung

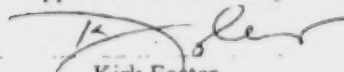
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DRP Chair

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Abstract

The computer program SEALOADS version 1.1 is able to predict the nonlinear ship motions as well as hydrodynamic pressure distribution and sea loads on the hull in the time-domain. The program consists of four independent sub-programs: RAD to compute the response function due to radiated waves; DIF to compute the response function due to diffracted waves; DAMP to compute the roll damping coefficients; and SEALOAD, the main program, to compute the ship motions, pressure and sea loads.

This manual describes the installation and operation of SEALOADS version 1.1 on a FreeBSD UNIX system. The structure and format of input and output data files are described, and example files are also provided in this manual.

Résumé

Le programme SEALOADS version 1.1 permet de prédire les mouvements non linéaires de navires de même que la répartition des pressions hydrodynamiques et les charges de mer sur la coque dans le domaine temporel. Le programme est formé de quatre sous-programmes indépendants : RAD, qui calcule la fonction de réponse causée par les ondes rayonnées; DIF, qui calcule la fonction de réponse causée par les ondes de diffraction; DAMP, qui calcule les coefficients d'amortissement de roulis; et SEALOAD, le programme principal, qui calcule les mouvements du navire, la pression et les charges de mer.

Ce manuel décrit les procédures d'installation et d'utilisation du programme SEALOADS version 1.1 sur un système FreeBSD UNIX. Il décrit aussi la structure et le format des fichiers de données d'entrée et de sortie et fournit des exemples de fichiers

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Executive summary

The computer program SEALOADS version 1.1 is able to predict the nonlinear ship motions as well as hydrodynamic pressure distribution and sea loads on the hull in the time-domain. The program consists of four independent sub-programs: RAD to compute the response function due to radiated waves; DIF to compute the response function due to diffracted waves; DAMP to compute the roll damping coefficients; and SEALOAD, the main program, to compute the ship motions, pressure and sea loads.

This User's Guide describes the installation and operation of SEALOADS version 1.1 on a FreeBSD UNIX system. The structure and format of input and output data files are described, and example files are also provided in this manual.

The results show that the computer program SEALOADS provides a practical means for calculating large-amplitude nonlinear loads that are beyond the realm of the conventional linear frequency-domain models.

The extreme loads are a key factor to be considered in the hull structural analysis, but because they occur very rarely, the characteristics of these loads are still poorly understood. SEALOADS serves as a practical analytical tool for examining them.

Future plans include further validation studies, refinement of the algorithms and/or theoretical models to improve the robustness, development of a more advanced method of calculating bow-flare impact force, application of the panel-free method for the computation of radiation and diffraction forces, and development of body-exact algorithm for large-amplitude motions. As well, development of a comprehensive analysis tool for the realistic hydroelastic response of the ship girder based on the framework of SEALOADS is envisaged.

Qiu W, Peng H., and Hsiung C.C. 2001. User's Guide for SEALOADS version 1.1: A Computer Program for Prediction of Nonlinear Ship Motions, Sea Loads, and Pressure Distribution in the Time Domain. CR 2001-165 Defence Research Establishment Atlantic

Sommaire

Le programme SEALOADS version 1.1 permet de prédire les mouvements non linéaires de navires de même que la répartition des pressions hydrodynamiques et les charges de mer sur la coque dans le domaine temporel. Le programme est formé de quatre sous-programmes indépendants : RAD, qui calcule la fonction de réponse causée par les ondes rayonnées; DIF, qui calcule la fonction de réponse causée par les ondes de diffraction; DAMP, qui calcule les coefficients d'amortissement de roulis; et SEALOAD, le programme principal, qui calcule les mouvements du navire, la pression et les charges de mer.

Ce manuel décrit les procédures d'installation et d'utilisation du programme SEALOADS version 1.1 sur un système FreeBSD UNIX. Il décrit aussi la structure et le format des fichiers de données d'entrée et de sortie et fournit des exemples de fichiers.

Les résultats montrent que le programme d'ordinateur SEALOADS fournit un moyen pratique pour calculer les charges non linéaires à large amplitude qui ne correspondent pas aux modèles du domaine des fréquences linéaires conventionnelles.

Les charges extrêmes sont un facteur dont il faut essentiellement tenir compte dans l'analyse de la structure de la coque, mais comme elles se produisent très rarement, leurs caractéristiques sont très mal connues. Le SEALOADS s'avère un outil d'analyse pratique pour les examiner.

Les futurs plans prévoient d'autres études de validation, un raffinement des algorithmes et/ou des modèles théoriques afin de renforcer la résistance, le développement d'une méthode plus avancée pour calculer la force de choc du dévers de l'étrave, l'application de la méthode sans écran pour calculer les forces de rayonnement et de diffraction et l'élaboration d'algorithmes précis de la coque pour les mouvements à large amplitude. De plus, on envisage de mettre au point un outil servant à analyser la réponse réelle de la poutre navire compte tenu du cadre d'applications de SEALOADS.

Qiu W, Peng H., and Hsiung C.C. 2001. User's Guide for SEALOADS version 1.1: A Computer Program for Prediction of Nonlinear Ship Motions, Sea Loads, and Pressure Distribution in the Time Domain. CR 2001-165 Defence Research Establishment Atlantic

User's Guide for SEALOADS Version 1.1

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2. PART I – PROGRAM: RAD
3. PART II – PROGRAM: DIF
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OVERVIEW OF SEALOADS VERSION 1.1

The SEALOADS program was developed to predict the nonlinear ship motions, hydrodynamic pressure distributions over the hull and sea loads in the time-domain.

This manual is to be used to execute SEALOADS Version 1.1. The most significant new capabilities introduced in Version 1.1 of SEALOADS include:

- Computation of the ship motions, hydrodynamic pressure distribution and sea loads in regular waves.
- Computation of motions, hydrodynamic pressure distribution and sea loads in irregular waves defined by significant wave height and spectral period. Short-term statistics are included.
- Computation of slamming forces.
- Consideration of effects of variable hydrodynamic coefficients.

The program suite consists of four independent programs:

- (1). RAD - program to compute the response function due to radiated waves,
- (2). DIF - program to compute the response function due to diffracted waves,
- (3). DAMP - program to compute the roll damping coefficients,
- (4). SEALOAD - kernel program to compute the ship motions, pressures and sea loads.

The four programs should be run in sequence so that the output generated by the preceding programs is used as input to subsequent programs. The running sequence is shown in Figure 1.

This manual consists of five parts to provide information necessary for installation of software and execution of the four modules of SEALOADS version 1.1. In addition to the

description in details of input and output formats, examples of input and output files are attached in Appendices.

Part I is concerned with the installation of all SEALOADS modules.

Part II gives detailed information on the input and output of the RAD module.

Part III provides the detailed information on the input and output of the DIF module. PART

IV presents the information on the input/output of the DAMP module.

Part V gives the information of the input and output of main program – SEALOAD.

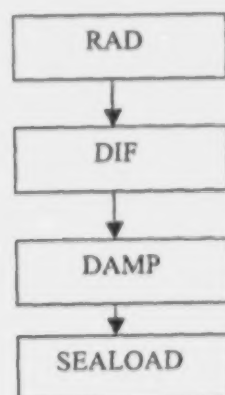
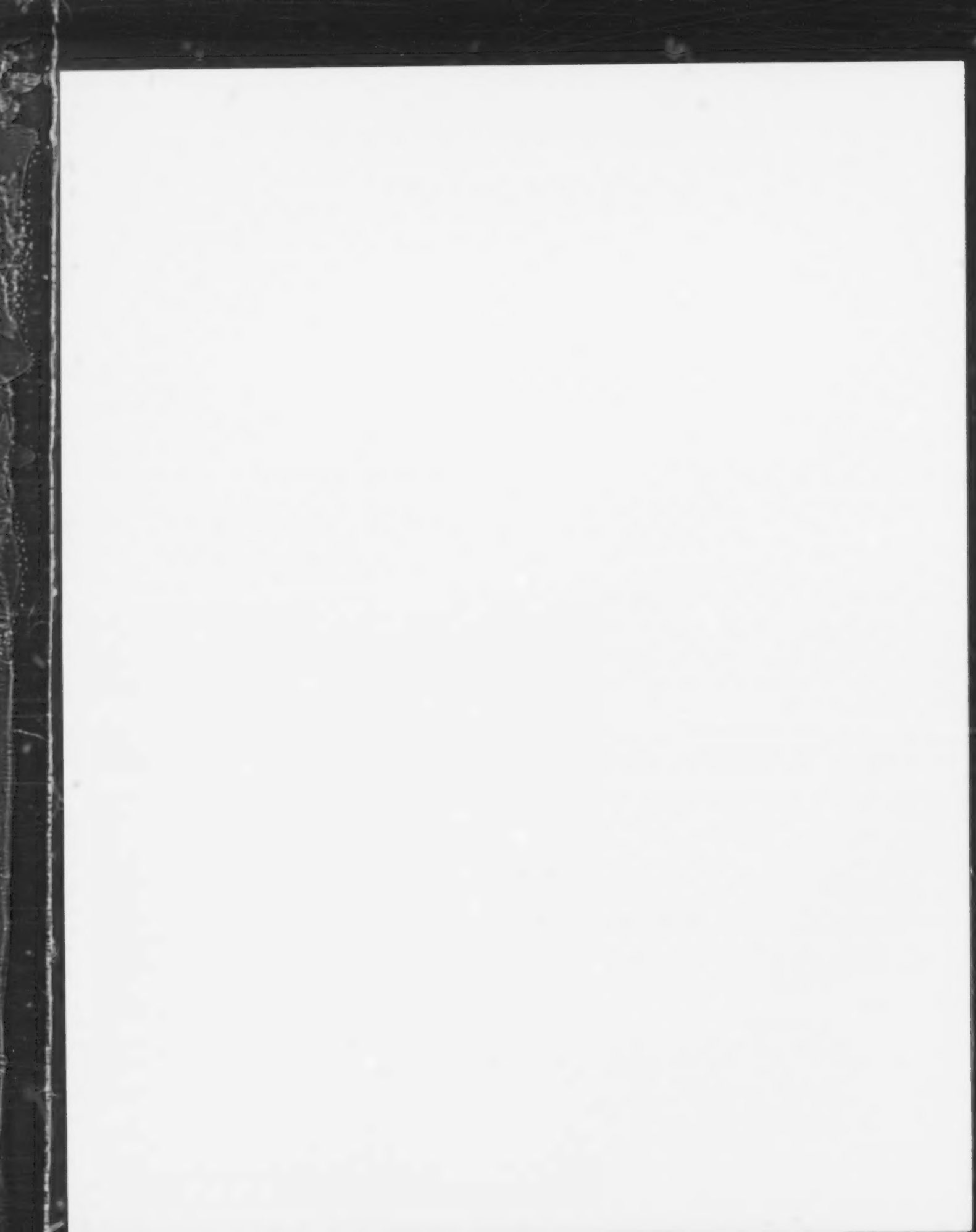


Figure 1. Flow chart of running sequence for SEALOADS Version 1.1



PART I INSTALLATION OF SEALOADS VERSION 1.1

SEALOADS VERSION 1.1 – PART I

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1 INTRODUCTION

This part of the User's Manual describes the installation and execution of SEALoads.

Currently, the source code and database of the program suite are supplied and can be installed on the hard disk of a computer operating with a UNIX or LINUX system only and using the FORTRAN77 compiler. A computer with a **minimum of 256Mbytes of RAM** is recommended. In the future, a version for Windows will be implemented.

2 DIRECTORY STRUCTURE

The directory structure is given in Figure 1. The contents of each directory are as follows:

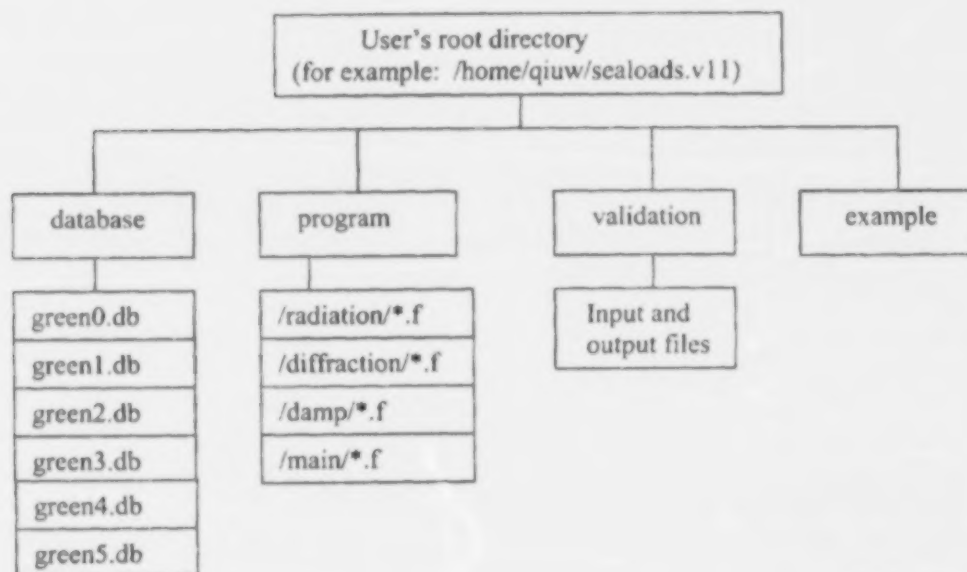


Figure 1. Directory structure

<code>/sealloads.v11</code>	main SEALOADS directory.
<code>/sealloads.v11/database</code>	common data for the computation of the time-domain Green function.
<code>/sealloads.v11/program/radiation</code>	source codes and Makefile. After compiling, the corresponding executable file – RAD will be generated in this directory.
<code>/sealloads.v11/program/diffraction</code>	source codes and Makefile. After compiling, the corresponding executable file – DIF will be generated in this directory.

<code>/sealloads.v11/program/damp</code>	source codes and Makefile. After compiling, the corresponding executable file – DAMP will be generated in this directory.
<code>/sealloads.v11/program/main</code>	source codes and Makefile. After compiling, the corresponding executable file – SEALOAD will be generated in this directory.
<code>/sealloads.v11/validation</code>	input files prepared by the user. After running the four programs, all output files are in this directory.
<code>/sealloads.v11/example</code>	all examples of files as provided in the Appendices of this User's Guide.

2.1 SOURCE CODE FILES FOR THE RADIATION PART

The following files are contained in the directory, `/Sealload.v11/program/radiation`:

<i>rad.f</i>	main program for the radiation part,
<i>doubbody.f</i>	compute double-body flow,
<i>gauss.f</i>	compute Gaussian points,
<i>geometry.f</i>	compute ship's hydrostatics,
<i>greent.f</i>	carry out integration of the time-domain Green function,
<i>input.f</i>	read input files,
<i>interp.f</i>	program for interpolations.
<i>phit.f</i>	solve potentials in the time domain,
<i>potent.f</i>	solve time-independent potentials,
<i>retarf.f</i>	compute response function of total forces,
<i>retarp.f</i>	compute response function of pressure on each panel,
<i>solver.f</i>	solve linear equations.

2.2 SOURCE CODE FILES FOR THE DIFFRACTION PART

The following files are contained in the directory, /Seaload.v11/program/diffraction:

<i>diff</i>	main program for the diffraction part,
<i>doubody.f</i>	compute double-body flow,
<i>gauss.f</i>	compute Gaussian points,
<i>geometry.f</i>	contains subroutines related to the geometry computation,
<i>greent.f</i>	carry out integration of the time-domain Green function,
<i>input.f</i>	read input files,
<i>interp.f</i>	program for interpolations.
<i>phi.f</i>	solve potentials in the time domain,
<i>potent.f</i>	solve time-independent potentials,
<i>retarf.f</i>	compute response function of total forces,
<i>retarp.f</i>	compute response function of pressure on each panel,
<i>solver.f</i>	solve the linear equations.

2.3 SOURCE CODE FILES FOR THE SEALOAD PART

The following files are contained in the directory, /Seaload.v11/program/main:

<i>damp.f</i>	compute the damping forces,
<i>euler.f</i>	first-order Euler solver
<i>fft.f</i>	carry out Fast Fourier Transform,
<i>force.f</i>	compute exciting forces,
<i>geometry.f</i>	contains subroutines related to the geometry computation,
<i>initial.f</i>	set up initial conditions,

<i>input.f</i>	read input files,
<i>interpolate.f</i>	contains subroutines related to interpolations,
<i>kij.f</i>	interpolate response functions,
<i>kutta.f</i>	the Runge-Kutta scheme,
<i>main.f</i>	main program for SEALOAD part,
<i>otherf.f</i>	compute forces from rudder, maneuvering, etc.,
<i>output.f</i>	give output of computational results,
<i>pressure.f</i>	compute pressure distribution,
<i>presinterp.f</i>	interpolate pressures at specific points
<i>seaload.f</i>	compute sea loads acting on a cross section,
<i>slam.f</i>	compute slamming forces,
<i>solver.f</i>	solve equations of ship motion by the Runge-Kutta scheme,
<i>statics.f</i>	carry out statistical analysis of ship motions, pressure and sea loads,
<i>transform.f</i>	carry out transformations between different coordinate systems,
<i>wave.f</i>	generate the required waves.

3 INSTALLATION

The procedure of installation is as follows:

STEP A. Make directories as described in Section 2.

STEP B. Copy all files into corresponding directories using *ftp* or *cp* command.

STEP C. Get into the directory, */sealloads.v11/program*, and run the following commands to generate the executable files:

- Enter */sealloads.v11/radiation* and run *make*; and the executable file RAD will be generated.
- Enter */sealloads.v11/diffraction* and run *make*; and the executable file DIF will be generated.
- Enter */sealloads.v11/damp* and run *make*; and the executable file DAMP will be generated.
- Enter */sealloads.v11/main* and run *make*; and the executable file SEALOAD will be generated.

STEP D. Return to the root directory of the user and edit the file *.cshrc* as follows:

- Set the path to */sealloads.v11/program/radiation*,
/sealloads.v11/program/diffraction, */sealloads.v11/program/damp*, and
/sealloads.v11/program/main.
- Run *source .cshrc*

STEP E. The user will run the four programs in the described sequence at the directory of */sealloads.v11/validation*, where a file named *sealloads.path* must be provided to set up the path to the database. An example of *sealloads.path* is as follows,

'/home/qiuw/sealloads.v11/database'

4 TROUBLE SHOOTING

The following problems *may* occur when using SEALOADS:

- Unable to run RAD, DIF, DAMP and SEALOAD

This may occur because the path is not correctly set up. We suggest that the user check the file *.cshrc*, and re-run *source .cshrc*.

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SEALOADS V1.1 – PART II

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1 INTRODUCTION

This chapter describes RAD (RADiation), a module in the SEALOADS package. The RAD module computes the response function of radiated waves. It also calculates ship hydrostatics for programs DIF, DAMP and SEALOAD.

The main text of this chapter describes input/output files, their format and record.

A brief description of information relevant to incident waves is given in Appendix I. Examples of input/output files for a Canadian Patrol Frigate (CPF) are presented in Appendices II to VIII.

2 INPUT AND OUTPUT FILES

2.1 INPUT FILES

To run RAD, the user needs to provide the following input files:

1. <filename>.ctr main input file which contains:
 - Principal ship dimensions and hydrostatics
 - Physical constants
 - Control indices for computing options
 - Time step data
 - Initial conditions
 - Incident wave information.
2. <filename>.msh containing information on nodes and panels under the waterline
3. <filename>.mass containing mass distribution of the ship

where <filename> is a suitable name string up to 25 characteristics in length.

Note that RAD, DIF, DAMP and SEALOAD share the same input file: <filename>.ctr and <filename>.msh. The format and description of these two files are given in Sections 3 and 4. Examples of input files are presented in Appendices II, III and IV.

2.2 OUTPUT FILES

Upon successful program execution, the following output files will be produced:

1. <filename>.chk Contains a display of information on ship hydrostatics and panel normals.

- | | |
|---------------------|--|
| 2. <filename>.data | Contains principal dimensions, hydrostatics and weight distribution. |
| 3. <filename>.adms | Contains matrices of added mass, damping and restoring forces. |
| 4. <filename>.geom | Contains the panel geometry information for the computation of viscous roll damping. |
| 5. <filename>.kijf | Contains response functions of total forces due to radiated waves |
| 6. <filename>.kijfx | Contains response functions of sea loads acting on a given cross section due to radiated waves |
| 7. <filename>.kijp | Contains response function of pressure at each panel centroid. |

The format and description of output files are given in Section 5 and examples of four output files are presented in Appendices V to VIII.

The organization of input/output files is shown in Figure 1.

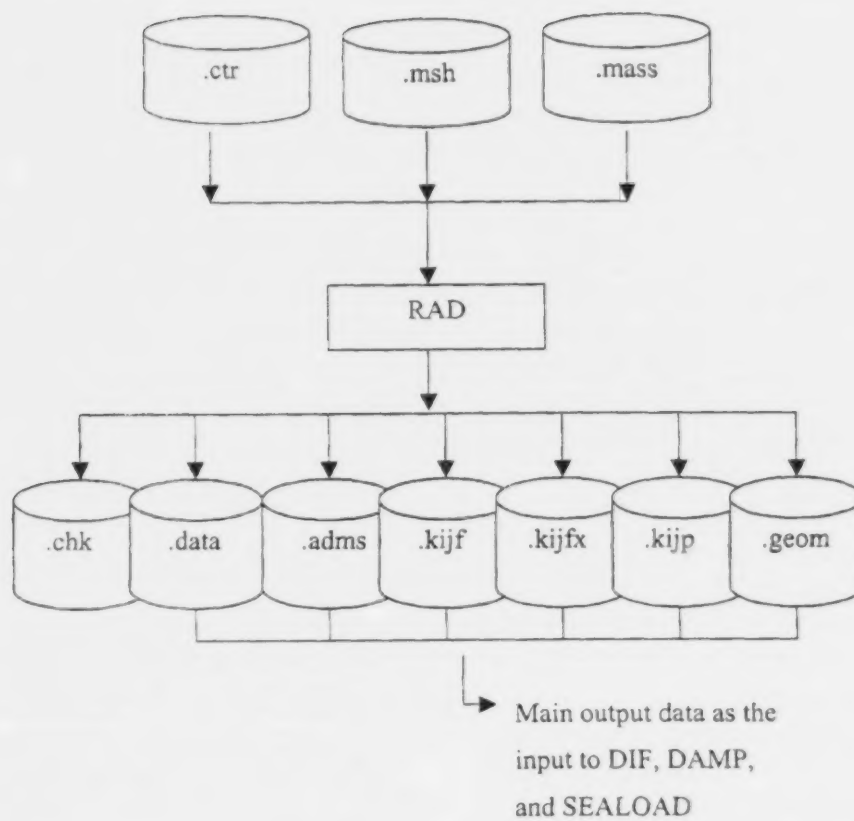


Figure 2.1 Organization of input/output files for program RAD

3 FORMAT OF INPUT FILES

The following is the format of the input files: <filename>.ctr, <filename>.mass and <filename>.msh. The definitions of records in these files are given in Section 4. Comment lines can be introduced by making '#' as the first character of the line. The program does not differentiate between upper and lower case characters. The input records are in the NAMELIST format, where a variable should be followed by '='. Note that space(s) between a variable or a value and '=' does not make any differences.

3.1 FORMAT OF <FILENAME>.CTR

Job title, ship name, user's name and data

&names

jobtitle

shipname

user

data

/end{names}

Principal dimensions

&shipdata

sl

sb

sd

cb

fn

xg

yg

zg

rx

ry

rz

volume

mass

ix

iy

iz

/end{shipdata}

Water density

&waterdensity

waterden

/end{waterdensity}

Control indices for options

&controls

presctr

sealoadctr

motionctr

initctr

slammctr

kmterm

kvadms

/end{controls}

Output control indices for options

&outputcontrol

```
outwave  
kanimation  
outpres  
/end{outputcontrol}
```

```
# Damping control
```

```
&dampcontrol  
dampmodel  
/end{dampcontrol}
```

```
# The cross-section for sea loads computation
```

```
&xsection  
numxcx  
xcx  
/end{xsection}
```

```
# Time step for simulation
```

```
&timedata  
dt0  
nretar0  
step  
numstep  
/end{timedata}
```

```
# Non-impulsive function coefficient
```

```
&impulsecoeff  
alfabar
```

/end{impulsecoeff}

Initial conditions

&init_conditions

motion_init(1), motion_init(2), ..., motion_init(6)

vel_init(1), vel_init(2), ..., vel_init(6)

acc_init(1), acc_init(2), ..., acc_init(6)

/end{init_conditions}

Control data for input waves

&waves

wavetype

beta

/end{waves}

Parameters for regular waves

&regularwave

wamp

wfreq

wphase

/end{regularwave}

Two parameter wave spectra – ISSC, JOHNSWAP and Bretschneider spectra

&twospectrum

hs

tp

/end{twospectrum}

Parameters for Ochi-Hubble wave spectrum

&OchiHubble

hs1

tp1

lambda1

hs2

tp2

lambda2

/end{OchiHubble}

Measured spectrum data

&measurespectrum

nspec

specfreq(1), specfreq(2), ... specfreq(nspec-1), specfreq(nspec)

spec(1), spec(2), ..., spec(nspec-1), spec(nspec)

/end{measurespectrum}

Parameters for Stokes waves

&stokeswave

wdepth

stoke_amp

stoke_freq

stoke_phase

/end{stokeswave}

Range of frequencies

&spectrumrange
numregular
lowfreq
upperfreq
/end{spectrumrange}

3.2 FORMAT OF <FILENAME>.MSH

```

nodenum, npanel
1, x(1), y(1), z(1)
2, x(2), y(2), z(2)
...
nodenum-1, x(nodenum-1), y(nodenum-1), z(nodenum-1)
nodenum, x(nodenum), y(nodenum), z(nodenum)
1, nodes(1,1), nodes(2,1), nodes(3,1), nodes(4,1)
2, nodes(1,2), nodes(2,2), nodes(3,2), nodes(4,2)
...
npanel-1, nodes(1,npanel-1), nodes(2,npanel-1), nodes(3,npanel-1), nodes(4,npanel-1)
npanel, nodes(1,npanel), nodes(2,npanel), nodes(3,npanel), nodes(4,npanel)

```

3.3 FORMAT OF <FILENAME>.MASS

```

nummass
dm(1)      xm(1)      ym(1)      zm(1)
dm(2)      xm(2)      ym(2)      zm(2)
...
dm(nummass-1)  xm(nummass-1)  ym(nummass-1)  zm(nummass-1)
dm(nummass)    xm(nummass)    ym(nummass)    zm(nummass)

```

4 DESCRIPTION OF INPUT FILES

4.1 DESCRIPTION OF <FILENAME>.CTR

4.1.1 NAMES RECORDS

- jobtitle - can be any set of characters (80 maximum) between single quotes (no embedded quotes)
- shipname - can be any set of characters (50 maximum) between single quotes (no embedded quotes)
- user - user's name, can be any set of characters (15 maximum) between single quotes (no embedded quotes)
- date - date or time, can be any set of characters (15 maximum) between single quotes (no embedded quotes)

4.1.2 SHIPDATA RECORDS

If any of these records are omitted then the values of records are obtained from the mesh geometry calculation and/or the weight distribution. All quantities, except where stated, are measured with respect to a right-handed co-ordinate system o, x, y, z , (Figure 4.1), fixed on the ship, with origin o , as the intersection of the centerline and the design waterline at the midship section, the x , -axis positive forward, the y , -axis positive towards the port and the z , -axis positive upwards. Figure 4.2 shows the three coordinate systems used in SEALOADS and convention for rotational motions.

- sl - length between perpendiculars (denoted as L_{pp}), *meter*.
 This record must not be omitted.
- sb - maximum beam (denoted as B), *meter*.
 This record must not be omitted.
- sd - draft, *meter*. **This record must not be omitted.**

cb	- block coefficient. This record must not be omitted.
fn	- Froude number. This record must not be omitted.
xg,yg,zg	- coordinates of the center of gravity (CG), <i>meter</i> . If this record is omitted the values are obtained from the weight distribution. If the weight distribution is not available then the CG will be placed on the center of buoyancy which is computed based on the mesh geometry.
rx	- radius of gyration for roll about CG, <i>meter</i> . If this record is omitted, $rx = 0.35B$.
ry	- radius of gyration for pitch about CG, <i>meter</i> . If this record is omitted, $ry = 0.25 L_{pp}$.
rz	- radius of gyration for yaw about CG, <i>meter</i> . If this record is omitted, $rz = 0.25 L_{pp}$.
volume	- volume of displacement, m^3 . If this record is omitted, it will be computed from the input mesh geometry.
mass	- total mass of ship, <i>kg</i> . If this record is omitted the value will be obtained from the weight distribution. If the weight distribution is not available then the total mass will be set as the product of water density and volume of displacement.
ixx, iyy, izz	- moments of inertia about CG. If these records are omitted, the values will be obtained from the input weight distribution. If the weight distribution file is not available, then $ixx = mass \times R_{xx}^2, \quad iyy = mass \times R_{yy}^2 \quad \text{and} \quad izz = mass \times R_{zz}^2$

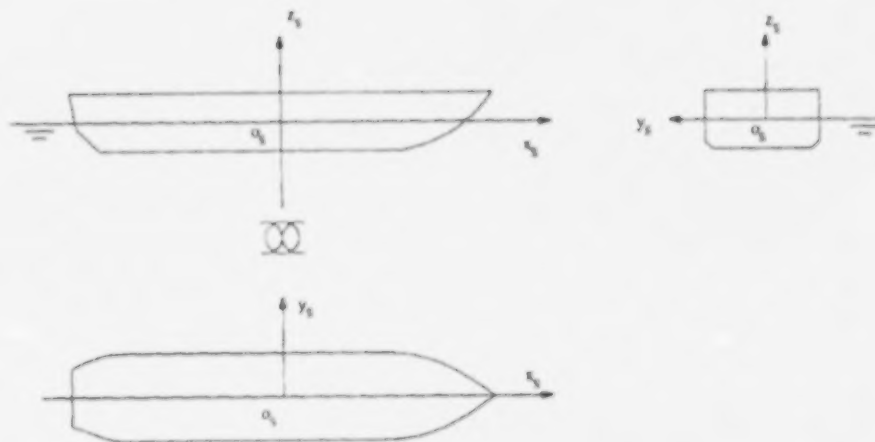
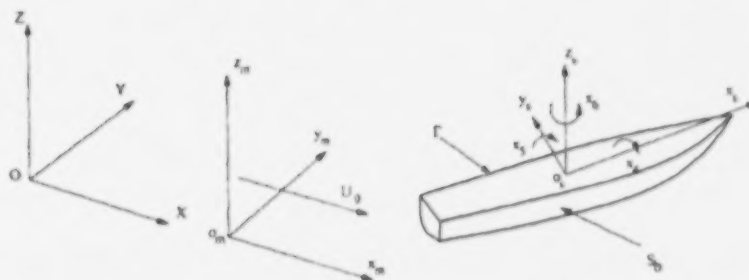


Figure 4.1 Coordinate system fixed on the ship



- $O-XYZ$: the space-fixed coordinate system
 $o_m - x_m, y_m, z_m$: the steady-moving coordinate system
 $o_s - x_s, y_s, z_s$: the ship-fixed coordinate system

Figure 4.2 Three coordinate systems used in SEALOADS

4.1.3 WATERDENSITY RECORD

waterden - density of water, kg / m^3 . If this record is omitted then it is set as 1024.0 kg / m^3 (representative value for salt water).

4.1.4 CONTROLS RECORDS

presctr	= 0, pressure distribution won't be computed. = 1, pressure distribution will be computed.
sealoadctr	= 0, sea loads acting on a specific cross-section won't be computed. = 1, sea loads acting on a specific cross-section will be computed.
motionctr	= 0, only heave, roll, and pitch motions will be computed. = 1, six degree-of-freedom motions will be computed.
initctr	= 0, ship starts motion at its rest position. = 1, ship starts motion at a given initial condition.
slammctr	= 0, slamming forces won't be computed. = 1, slamming forces will be computed.
kmterm	= -1, no m-terms will be considered. = 0, simplified m-terms will be considered. = 1, full m-terms will be computed from the integral equation.
kvadms	= 0, hydrodynamic coefficients computed on mean wetted surface will be used for the computation of ship motions. = 1, hydrodynamic coefficients computed variable wetted surfaces will be used for the computation of ship motions. = 2, variable hydrodynamic coefficients and response functions will be used for the computation of ship motions.

The above records cannot be omitted.

4.1.5 OUTPUTCONTROL RECORD

This record contains the following options for output:

- outwave = 0, history of wave elevation at the origin of the steady moving coordinate system will be given as output.
 = 1, history of wave elevation at the origin of the space-fixed coordinate system will be given as output.
- kanimation = 0, animation file for motions and pressures won't be produced.
 = 1, animation file for motions and pressures will be produced in Tecplot format.
- outpres = -1, no pressures will be output
 = 1, pressures on input points will be output.
 <filename>.presxyz has to be prepared (see Part V).
 = 2, pressures on centroids of all panels will be output.

Note that coordinate systems are shown in Figure 4.2.

4.1.6 DAMPCONTROL RECORD

The user can select one of five damping models to calculate the viscous roll damping coefficients. The damping models are described in the Theoretical Manual.

dampmodel = 0, empirical formulae will be used to calculate the damping coefficients α_1 and α_2 .

= 1, damping model $\alpha_1 \dot{\phi} + \alpha_2 |\dot{\phi}| \dot{\phi}$ is used.

= 2, damping model $\alpha_1 \dot{\phi} + \alpha_2 |\dot{\phi}|^2 \dot{\phi}$ is used.

= 3, damping model $\alpha_1 \dot{\phi} + \alpha_2 \dot{\phi}^3$ is used.

= 4, damping model $\alpha_1 \dot{\phi} + \alpha_2 \dot{\phi} |\dot{\phi}|$ is used.

4.1.7 XSECTION RECORD

numxcx - the number of cross-sections where sea loads will be computed.

xcx(i) - locations of the cross-section where sea loads will be computed (see Figure 4.3). $xcx=0.0$ amidship, $xcx=sl/2.0$ at FP and $xcx=-sl/2.0$ at AP. ($i=1, \dots, numxcx$)

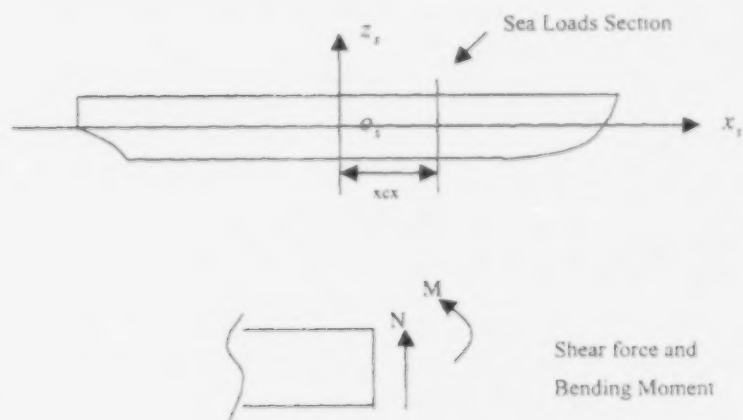


Figure 4.3 Definitions of sea loads section and sea loads

4.1.8 TIMEDATA RECORDS

- dt0 - time step used in computations for the response functions in RAD and DIF. The recommended value is in the range of 0.25 to 0.5s for a full-scale ship.
- nretar0 - number of time steps used in computations of response functions in RAD and DIF. The maximum value is 200.
- step - time step used in the main program, SEALOAD, for simulation. If this record is omitted, then $\text{step} = \text{dt0}/6$. The maximum value of $\text{dt0}/\text{step}$ is 50.
- numstep - number of time steps used in SEALOAD. The maximum value is 50,000.

4.1.9 IMPULSECOEFF RECORD

- alfabar - coefficient for the non-impulsive function, $\xi_j(t) = \sqrt{\frac{\bar{\alpha}}{\pi}} e^{-\bar{\alpha}t}$. If this record is omitted, $\bar{\alpha} = 0.1$. The recommended value is in the range of 0.05 to 0.25.

4.1.10 INIT_CONDITIONS RECORDS

If $\text{initctr}=0$, these records can be omitted.

- motion_init - initial motions. $\text{motion\_init}(1)$, $\text{motion\_init}(2)$, $\text{motion\_init}(3)$, $\text{motion\_init}(4)$, $\text{motion\_init}(5)$ and $\text{motion\_init}(6)$ represent the initial surge, sway, heave, roll, pitch and yaw motions, respectively. Note that these motions are in the steady-moving coordinate system.
- vel_init - initial velocities. $\text{vel\_init}(1)$, $\text{vel\_init}(2)$, ..., $\text{vel\_init}(5)$ and $\text{vel\_init}(6)$ are the six-degree-of-freedom velocities in the ship-fixed coordinate system.

acc_init - initial accelerations in the ship-fixed coordinate system. **acc_init(1)**, **acc_init(2)**, ..., and **acc_init(6)** are the six-degree-of-freedom accelerations in the ship-fixed system.

Note that the translational motion displacements are all in *meters* and the angular displacements are in *radians*.

4.1.11 WAVES RECORDS

wavetype - types of incident waves.
 =0, regular waves
 =1, ISSC spectrum (two parameters)
 =2, JONSWAP spectrum (two parameters)
 =3, Bretschneider spectrum (two parameters)
 =4, Ochi-Hubble six parametric spectrum
 =5, measured spectrum
 =6, second-order Stokes waves

beta - ship heading in *degrees*. 0° is following waves, 90° is starboard beam waves, and 180° is head waves (see Figure 4.4).

Descriptions of regular waves, various wave spectra and second-order Stokes waves are given in Appendix I.

4.1.12 REGULARWAVE RECORDS

If **wavetype** $\neq 0$, the following records can be omitted.

wamp - wave amplitude, *meter*.
wfreq - wave frequency, *rad/sec*.
wphase - the initial phase angle, *degree*.

4.1.13 TWOSPECTRUM RECORDS

If wavetype $\neq$ 1, 2, or 3, the following records can be omitted.

hs - significant wave height, *meter*.
 tp - peak wave period, *second*.

4.1.14 OCHIHUBBLE RECORDS

If wavetype $\neq$ 4, the following records can be omitted.

hs1, hs2 - significant wave heights, *meter*, for components 1 and 2.
 tp1, tp2 - peak wave periods, *second*, for components 1 and 2.
 lambda1 - spectra shape parameter for component 1.
 lambda2 - spectra shape parameter for component 2.

4.1.15 MEASURESPECTRUM RECORDS

If wavetype $\neq$ 5, the following records can be omitted.

nspec - number of measured wave spectra values.
 specfreq (i) - wave frequency, *rad/s*, $i=1,2, \dots, \text{nspec}$.
 spec (i) - measured spectra value, *meter²/(rad/s)*, $i=1,2, \dots, \text{nspec}$.

4.1.16 STOKESWAVE RECORDS

If wavetype $\neq$ 6, the following records can be omitted.

wdepth - depth of water, *meter*.
 stoke_amp - wave amplitude, *meter*.
 stoke_freq - wave frequency, *rad/sec*.

stoke_phase - initial phase angle, *degree*.

4.1.17 SPECTRUMRANGE RECORDS

If wavetype=0 or 6, the following records can be omitted.

numregular - number of regular wave components in the irregular waves.

lowfreq - lower end of frequency in the spectrum, *rad/sec*.

upperfreq - upper limit of frequency in the spectrum, *rad/sec*.

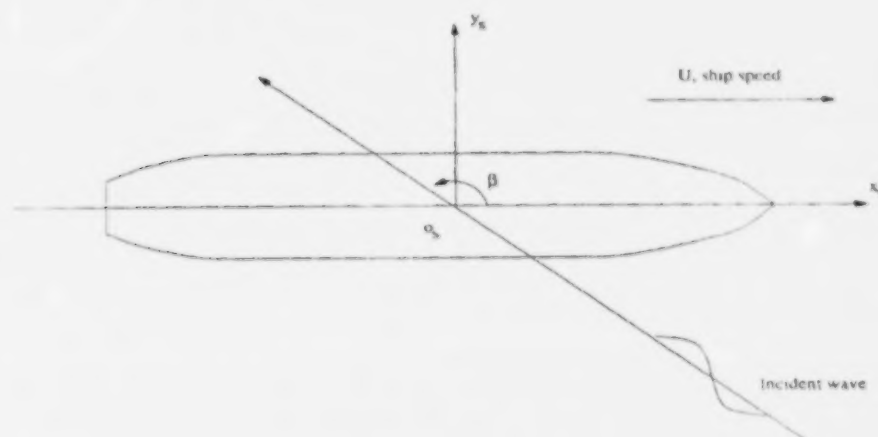


Figure 4.4 Definition of wave heading

4.2 DESCRIPTION OF <FILENAME>.MSH

The underwater surface of the port side of hull is discretized into a number of quadrilateral panels. This file contains the information on nodes and panel connectivity.

RECORD 1 - NODENUM, NPANEL

nodenum	- number of nodes on the port side of hull (500 maximum)
npanel	- number of panels on the port side of hull (260 maximum)

RECORD 2 - NO(I), XS(I), YS(I), ZS(I)

NO(I)	- number identifying the <i>i</i> th node point.
XS(I), YS(I), ZS(I)	- coordinates of the <i>i</i> th node point. The coordinates are with respect to a right-handed coordinate system with the origin at the intersection of centerline and waterline at the midship section (see Figure 4.1).

Repeat above record for $I=1, 2, \dots, \text{nodenum}$.

RECORD 3 - NO(I), PANEL(1,I), PANEL(2,I), PANEL(3,I), PANEL(4,I)

NO(I)	- number identifying the <i>i</i> th panel.
PANEL(1,I)	- first node of the <i>i</i> th panel.
PANEL(2,I)	- second node of the <i>i</i> th panel.
PANEL(3,I)	- third node of the <i>i</i> th panel.
PANEL(4,I)	- fourth node of the <i>i</i> th panel.

Repeat above record for $I=1, 2, \dots, \text{npanel}$.

4.3 FORMAT OF <FILENAME>.MASS

Computation of sea loads requires an accurate description of ship mass distribution. It is assumed that the mass is uniformly distributed between given segments. The segment can be between any x_1 and x_2 entered by the user (see Figure 4.6) and segments need not necessarily be of equal length. Note that if a cross section, xcx , where sea loads are to be computed, is located in a segment (x_1, x_2) , then the segment must be separated into two segments (x_1, xcx) and (xcx, x_2) .

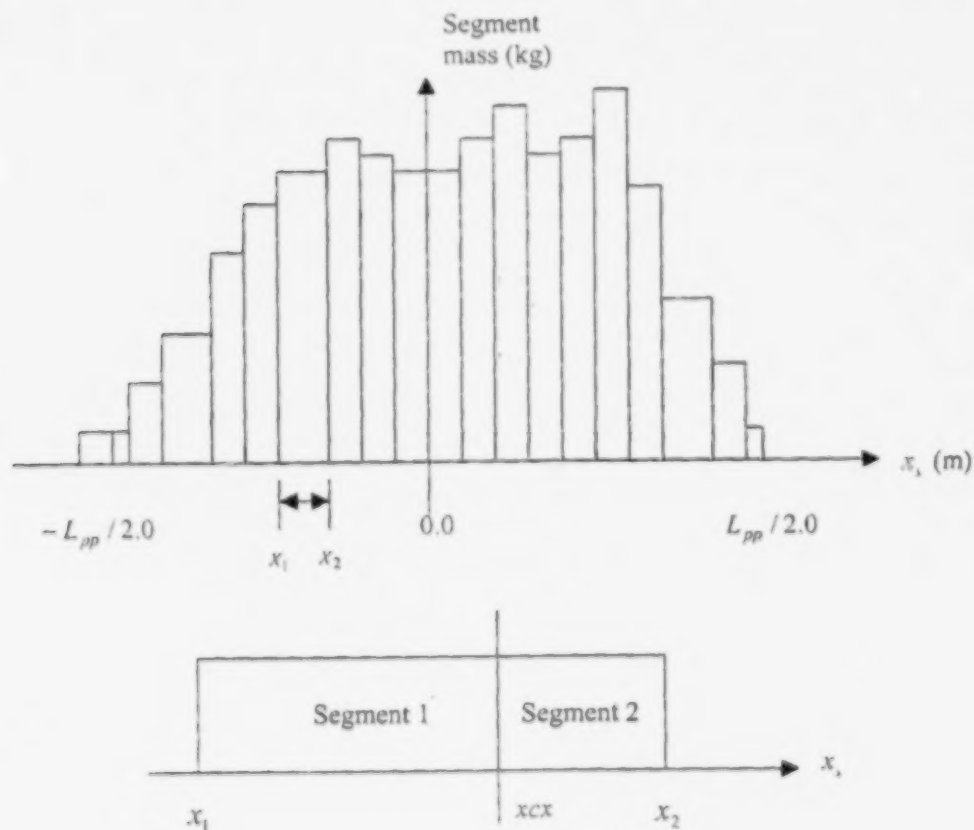


Figure 4.6 Mass distribution

4.1.5 NUMMASS RECORD

NUMMASS number of mass segments (100 maximum)

4.1.5 MASS SEGMENT RECORD

DM(1)	XDM(1)	YDM(1)	ZDM(1)
DM(2)	XDM(2)	YDM(2)	ZDM(2)
...	...	...	...
DM(nummass-1)	XDM(nummass-1)	YDM(nummass-1)	ZDM(nummass-1)
DM(nummass)	XDM(nummass)	YDM(nummass)	ZDM(nummass)

DM(<i>i</i>)	mass of segment <i>i</i> , <i>kg</i> .
XDM(<i>i</i>)	x-coordinate, the center of gravity of segment <i>i</i> , <i>meter</i>
YDM(<i>i</i>)	y-coordinate, the center of gravity of segment <i>i</i> , <i>meter</i>
ZDM(<i>i</i>)	z-coordinate, the center of gravity of segment <i>i</i> , <i>meter</i>

NOTE: The coordinates are given with respect to a right-handed o, x, y, z , coordinate system, with the origin o , at the intersection of the centerplane and the calm water plane at the midship section (see Figure 4.1).

5 DESCRIPTION OF OUTPUT FILES

The following is a brief description of the records in the output files <filename>.chk, <filename>.data, <filename>.adms, <filename>.geom, <filename>.kijf, <filename>.kijfx, and <filename>.kijp.

5.1 <FILENAME>.CHK RECORDS

This file contains the following information:

- The title page
- Summary of input hydrostatics
- Summary of calculated hydrostatics
- Normal of each panel

The format of this file is given as below:

Record No.	Description
1	Job title
2	Ship name
3	User's name
4	Date
5	L_{pp}
6	B
7	Draft (sd)
8	Block Coefficient (cb)
9	Froude number (fn)
10	Center of gravity (xg, yg and zg)

11	rx
12	ry
13	rz
14	ix
15	iy
16	iz
17	Volume displacement
18	mass
19	Computed center of gravity (xg, yg and zg)
20	Computed gyradius - rx
21	Computed ry
22	Computed rz
23	Computed moment of inertia - ix
24	Computed iy
25	Computed iz
26	Volume displacement computed along x-direction
27	Volume displacement computed along y-direction
28	Volume displacement computed along z-direction
29	Computed total mass
30	Computed area of wetted surface
31	Computed area of waterplane
32	Computed center of floatation, (xb,yb,zb)
33	Normal of each panel

Note that the record number is not shown in the output file.

5.2 <FILENAME>.DATA

This file contains the principal dimensions, hydrostatics and mass distributions. This file is the input file for programs DIF, DAMP, SEALOAD and SEAPOST.

Record	Description
1	sl, sb, sd, cb, fn, xg, yg, zg, rxx, ryy, rzz, uship, volume, mass, ixx, iyy, izz
2	nummass, dm, xdm, ydm, zdm, fxg, fyg, fzg, fmass, frxx, fryy

In record (1), the symbol, uship, is the ship speed in *meter/second*. In record (2), symbols, fxg, fyg, fzg, are the center of gravity of the fore-body between the sea loads section *xcx* considered and FP; fmass is the mass of the fore-body; frxx and fryy are the radii of gyration about the x and y axis, respectively; nummass, dm, xdm, ydm and zdm are described in section 4.3.

5.3 <FILENAME>.ADMS

This file contains the information on added mass, restoring force and damping coefficients. The file is the input file to SEALOAD.

Record	Description
1	Added mass matrix (6x6)
2	Restoring force coefficient matrix (6x6)
3	Damping coefficient matrix (6x6)
4	Added mass matrix of the fore-body, which is from the section <i>xcx</i> to FP
5	Restoring force coefficient matrix of the fore-body
6	Damping coefficient matrix of the fore-body
7	Added mass matrix of the aft-body, which is the portion from AP to the section <i>xcx</i>
8	Restoring force coefficient matrix of the aft-body
9	Damping coefficient matrix of the aft-body

4.4 <FILENAME>.GEOM

This file contains the panel geometry information, which can be used for estimating viscous roll damping coefficients in Part IV. The format is as follows:

cy(i)	cz(i)	area(i)	coordinates of the centroid of panel i and area of panel i ($i=1,2, \dots, \text{num}$).
ny(i)	nz(i)		the normal directions of panel i along y- and z-axis ($i=1,2, \dots, \text{num}$)

where num is the number of panels.

5.5 <FILENAME>.KIJF

This file contains the response function of the total force acting on the ship body. It is an input file to SEALOAD.

Time	Response function
t(1)	Response function K_y at time $t = 0$
t(2)	Response function K_y at time $t = dt0$
t(3)	Response function K_y at time $t = 2 \times dt0$
...	...
t(nretar0)	Response function K_y at time $t = nretar0 \times dt0$
t(nretar0+1)	Response function K_y at time $t = (nretar0 + 1) \times dt0$

where dt0 is the time step used in computations for the response functions in RAD and DIF and nretar0 is the number of corresponding time steps.

5.6 <FILENAME>.KIJFX

This file contains the response functions of sea loads acting on cross-sections. It is an input file to SEALOAD.

For cross-sections, $i=1, \dots, \text{numxcx}$, the following response functions are output:

Time	Response function
t(1)	Response function K_y^x (6x6) at time 0
t(2)	Response function K_y^x at time $t = dt0$
t(3)	Response function K_y^x at time $t = 2 \times dt0$
...	...
t(nretar0)	Response function K_y^x at time $t = nretar0 \times dt0$
t(nretar0+1)	Response function K_y^x at time $t = (nretar0 + 1) \times dt0$

where dt0 is the time step used in computations for the response functions in RAD and DIF and nretar0 is the number of corresponding time steps.

5.7 <FILENAME>.KIJP

This file contains the response functions of pressure on each panel. It is an input file to SEALOAD, and is used for pressure distribution computation. If presctr=0, this file won't be produced.

Time	Response function
t(1)	Response function K_y^p ($6 \times npanel$) at time $t = 0$ Mode 1: $K_y^p(1,2,\dots,npanel)$ Mode 2: $K_y^p(1,2,\dots,npanel)$

	...	...
	Mode 5: $K_y^p(1,2,\dots,npanel)$	
	Mode 6: $K_y^p(1,2,\dots,npanel)$	
t(2)	Response function K_y^p at time $t = dt0$	
t(3)	Response function K_y^p at time $t = 2 \times dt0$	
...	...	
t(nretar0)	Response	function K_y^p at time $t = nretar0 \times dt0$
t(nretar0+1)	Response	function K_y^p at time $t = (nretar0 + 1) \times dt0$

where dt0 is the time step used in computations for the response functions in RAD and DIF and nretar0 is the number of corresponding time steps.

REFERENCES

- [1] ITTC Seakeeping Committee Report, in *15th International Towing Tank Conference* (The Hague, September 1978), Vol. 1, pp. 55-114.
- [2] McTaggart, K., "SHIPMO7, An updated strip theory program for predicting ship motions and sea loads in waves", DREA Technical Memorandum 96/243, March 1997.
- [3] Ochi, M.K. and Hubble, E.N., "Six-parameter wave spectra", in *15th Coastal Engineering Conference* (Honolulu, 1976), Vol. 1, pp.301-328.
- [4] Sarpkaya, T. and Isaacson, M., Mechanics of wave forces on offshore structures, Van Nostrand Reinhold Company, New York, 1981, pp. 174-175.
- [5] Schmitke, R.T., "Ship sway, roll, and yaw motions in oblique seas", Transactoin SNAME, Vol. 86, 1978, pp. 26-46.

APPENDIX I WAVE SPECTRA, REGULAR WAVES AND STOKES WAVES

I.1 ISSC WAVE SPECTRUM

The ISSC spectrum [1,2] is expressed as follows:

$$S(\omega) = \frac{173 H_s^2}{T_1^4 \omega^5} e^{-\frac{691}{T_1^4 \omega^4}} \quad (I-1)$$

where $S(\omega)$ is the spectral density function, H_s is the significant wave height in meter, ω is the wave frequency (rad/s), T_1 corresponds to the energy averaged frequency using the following relationship for a fully developed sea:

$$T_1 = 0.773 T_p \quad (I-2)$$

$$T_1 = 2\pi \frac{\int_0^\infty S(\omega) d\omega}{\int_0^\infty \omega S(\omega) d\omega} \quad (I-3)$$

and T_p is the peak wave period.

I.2 TWO PARAMETER JONSWAP SPECTRUM

The JONSWAP spectrum models relatively high-peaked spectra typically encountered in fetch-limited regions [1,2]. In SEALoads, a two parameter JONSWAP spectrum with $\gamma = 3.3$ is used as follows:

$$S(\omega) = 0.2044 H_S^2 \frac{\omega_p^4}{\omega^5} \exp \left[-1.25 \frac{\omega_p^4}{\omega^4} \right] \gamma^\kappa \quad (1-4)$$

$$\kappa = \exp \left[\frac{-(\omega - \omega_p)^2}{2\sigma^2 \omega_p^2} \right] \quad (1-5)$$

$$\sigma = \begin{cases} 0.07 & \text{for } \omega \leq \omega_p \\ 0.09 & \text{for } \omega > \omega_p \end{cases} \quad (1-6)$$

where ω_p is the peak wave frequency.

1.3 BRETSCHNEIDER SPECTRUM

SEALOADS uses the Bretschneider spectrum taken from the 15th International Towing Tank Conference (ITTC) [1] as follows:

$$S(\omega) = \frac{487}{T_p^4} \frac{H_S^2}{\omega^5} \exp \left[\frac{-1948}{T_p^4 \omega^4} \right] \quad (1-7)$$

1.4 OCHI AND HUBBLE SIX PARAMETER SPECTRUM

The Ochi-Hubble six parameter spectrum [3] models collinear swell and sea components as follows:

$$S(\omega) = \frac{1}{4} \sum_{i=1}^2 \frac{\left[\left(\frac{4\lambda_i + 1}{4} \right) \omega_{pi}^4 \right]^{\lambda_i} \zeta_i^2 \exp \left[- \left(\frac{4\lambda_i + 1}{4} \right) \left(\frac{\omega_{pi}}{\omega} \right)^4 \right]}{\Gamma(\lambda_i) \omega^{(4\lambda_i + 1)}} \quad (1-8)$$

where λ_i , ζ_i , and ω_{pi} are the spectral shape parameter, significant wave height, and peak frequency for component i , respectively.

1.5 REGULAR WAVES

The surface wave elevation, η , and velocity potential function, ϕ , of regular incident wave can be written as follows:

$$\eta = A \cos[k(x \cos \beta + y \sin \beta) - \omega t] \quad (1-9)$$

$$\phi = \frac{g}{\omega} A e^{kz} \sin[k(x \cos \beta + y \sin \beta) - \omega t] \quad (1-10)$$

where A is the wave amplitude; k is the wave number; β is the wave heading; x , y and z are the coordinates of a field point; ω is the wave frequency; t is time and g is the acceleration of gravity.

1.6 STOKES SECOND-ORDER WAVES

The surface wave elevation and velocity potential of a Stokes second-order wave for deep water are as follows [4]:

$$\eta = \frac{H}{2} \cos \theta + \frac{H}{8} \frac{\pi H}{L} \frac{\cosh(kd)}{\sinh^3(kd)} [2 + \cosh(2kd)] \cos 2\theta \quad (1-11)$$

$$\phi = \frac{\pi H}{kT} \frac{\cosh(ks)}{\sinh(kd)} \sin \theta + \frac{3}{8} \frac{\pi H}{kT} \frac{\pi H}{L} \frac{\cosh(2ks)}{\sinh^4(kd)} \sin 2\theta \quad (1-12)$$

where H is the wave height; T is the wave period; L is the wave length; k is the wave number; d is the water depth; $\theta = kx - \omega t$ and ω is the wave frequency; $s = z + d$; and x and z are coordinates of a field point, respectively.

APPENDIX II CPF.CTR

```
# Ship name, job title, user and data
```

```
&names
jobtitle='CPF,deep departure, Fn=0.12, Steepness=1/50, Head Seas'
shipname='cpf'
user='qiuw'
date='May 4, 1999'
/
```

```
# Principal dimensions
```

```
&shipdata
sl=124 5
sb=14 8
sd=4.97
cb=0.5
fn=0.12
rxx=5.18
ryy=31.125
rzz=31.125
xg=-2 656
yg=0.0
zg=1.348
/end(shipdata)
```

```
# water density
```

```
&waterdensity
waterden=1024.0
/endwaterdensity
```

```
# control indices
```

```
&controls
presctr=1
sealoadctr=1
motionctr=1
initctr=0
kmterm=0
kvadms=0
/end(controls)
```

```
# output controls
```

```
&outputcontrol
outwave=0
kanimation=0
outpres=0
/end(outputcontrol)
```

```
# damping model
```

```
&dampcontrol
dampmodel=0
/end(dampcontrol)
```

```
# cross-section for sea loads computation
```

```
&xsection
numxcx=7
xcx=46.6875, 31.125, 15.5625, 0.0, -23.0325, -31.125, -46.6875
/end(xsection)
```

```

# time steps for simulation
&timedata
dt0=0.20
nretar0=200
step=0.02
numstep=20000
/end(timedata)

# Non-impulsive coefficient
&impulsecoeff
alfabar=0.1
/end(impulsecoeff)

# Initial conditions
&init_conditions
motion_init=
vel_init =
acc_init =
/end(init_conditions)

# input waves
&waves
wavetype=0
beta=180.0
/end(waves)

# regular waves
&regularwave
wamp = 1.357
wfreq = 0.67
wphase= 0.0
/end(regularwave)

# Two parameter wave spectra - ISSC, JONSWAP and Bretschneider spectra
&twospectrum
Hs=5.0
Tp=11.0
/end(twospectrum)

# Ochi-Hubble six parameter wave spectrum
&OchiHubble
Hs1=
Tp1=
Lambda1=
Hs2=
Tp2=
Lambda2=
/end(ochihubble)

# Measured spectrum
&measurespectrum
nspec=
specfreq =
spec =
/end(measurespectrum)

# Stokes wave
&stokeswave
wdepth = 20.0
stoke_amp = 2.5
stoke_freq = 0.9

```

```
stoke_phase = 0.0  
/end(stokeswave)  
  
# Range of frequencies  
  
%spectrumrange  
numregular=2000  
lowfreq =0.001  
upperfreq =2.5  
/end(spectrumrange)
```

APPENDIX III CPF.MSH

312	248			
1	60.17500	0.00000	-2.96049	
2	60.17627	0.00000	-2.93876	
3	60.32202	0.00000	-2.72316	
4	60.96848	0.00000	-1.77366	
5	61.56566	0.00000	-0.93880	
6	62.25000	0.00000	0.00000	
7	58.02313	0.00000	-4.12256	
8	58.87828	0.10072	-3.20409	
...	...	...	...	...
310	-62.25000	4.57625	-0.34250	
311	-62.25000	5.40000	0.00000	
312	-62.25000	5.00196	-0.33770	
1	1	2	8	7
2	2	3	9	8
3	3	4	10	9
4	4	5	11	10
5	5	6	12	11
...	...	...	...	...
235	281	282	288	287
236	283	284	290	289
237	284	285	291	290

APPENDIX IV CPF.MASS

```

22
20350.0 65.12 0.0 0.0
57570.0 58.25 0.0 0.0
136130 51.35 0.0 0.0
152440. 44.07 0.0 0.0
150200. 38.40 0.0 0.0
221180. 33.24 0.0 0.0
298920. 26.18 0.0 0.0
247840. 20.17 0.0 0.0
327890. 15.18 0.0 0.0
296710 7.87 0.0 0.0
310480. 3.59 0.0 0.0
378400. -2.42 0.0 0.0
349340. -10.54 0.0 0.0
263730. -16.83 0.0 0.0
373920. -23.03 0.0 0.0
309520. -30.13 0.0 0.0
215690. -35.73 0.0 0.0
148290 -40.09 0.0 0.0
143120 -46.85 0.0 0.0
170370. -52.95 0.0 0.0
147150. -58.79 0.0 0.0
17760 0 -63.41 0.0 0.0

```

APPENDIX V CPF.CHK

CPF, deep departure, Fn=0.12, Steepness=1/50, Head Seas
CPF

May 4, 1999

user = qluw

Principle Dimensions and Hydrostatics:

Length, between perpendiculars,	Lpp (m):	124.5
Breadth, maximum,	B (m):	14.8000002
Draft, mean,	T (m):	4.96999979
Cubic coefficient,	Cb :	0.5
The Froude number,	Fn :	0.119999997
Center of Gravity,	(xg,yg,zg) (m):	-2.6559999 0 1.34800005
Radius of gyration,	rxx (m):	5.17999983
Radius of gyration,	ryy (m):	31.125
Radius of gyration,	rzx (m):	31.125
Mass moment of inertia,	ixx(m^3):	124420152.
Mass moment of inertia,	iyy(m^3):	4.49210573E+09
Mass moment of inertia,	izz(m^3):	4.49210573E+09
Volume of displacement,	volume (m^3):	4528.25928
Mass of displacement,	mass (kg):	4636937.5

Computed Hydrostatics:

Center of Gravity,	(xg,yg,zg) (m):	-2.82247686 0. 0
Radius of gyration,	rxx (m):	0.
Radius of gyration,	ryy (m):	30.0821381
Radius of gyration,	rzx (m):	30.0821381
Mass moment of inertia,	ixx(m^3):	75857792.
Mass moment of inertia,	iyy(m^3):	3.25779712E+09
Mass moment of inertia,	izz(m^3):	3.2842496E+09
Volume of displacement	volume-x (m^3):	4533.86084
Volume of displacement	volume-y (m^3):	4528.25928
Volume of displacement	volume-z (m^3):	4528.37109
Volume of displacement	volume (m^3):	4528.25928
Weight of displacement,	mass (kg):	4737000
Area of wetted surface	swet (m^2):	1979.85803
Area of waterplane	swp (m^2):	1435.60962
Center of floatation,	(xb,yb,zb) (m):	-2.84567499 0. -1.88667929

NORMALS IN SIX MODES

1	0.1146	0.9713	-0.2084	4.6229	12.3145	59.9256
2	0.1153	0.9834	-0.1402	4.1868	8.2231	61.1024
..	..	..	..	..	..	..

APPENDIX VI CPF.DATA

[illegible]

APPENDIX VII CPF.ADMS

[illegible]

APPENDIX VIII CPF.GEOM

0 032865	-3.418532	0.520215
0.076484	-2.920429	0.421652
0.112521	-2.255975	1.618515
0.172856	-1.358301	1.974605
0.261594	-0.454150	2.745103
0.112524	-3.907869	2.254531
0.285492	-3.148570	1.744717
0.414458	-2.359323	2.839375
0.577571	-1.421646	2.838422
0.796194	-0.479062	3.117716
0.203072	-4.303938	3.514448
0.543230	-3.348510	2.823730
0.794021	-2.428690	3.137213
1.045803	-1.464217	3.122608
1.341579	-0.492384	3.281622
0.298024	-4.443467	3.682704
0.795521	-3.440398	3.314135
1.161709	-2.456208	3.254949
1.501905	-1.479014	3.234993
1.870163	-0.496685	3.366478
0.392190	-4.473952	3.934644
1.049922	-3.468110	3.587989
1.525922	-2.463423	3.369428
1.946479	-1.482685	3.321756
2.381925	-0.498340	3.443786
0.492468	-4.483559	4.306034
1.318983	-3.480544	3.840914
1.901685	-2.471598	3.457913
2.391279	-1.493572	3.400615
2.883692	-0.503982	3.544146
0.600002	-4.494351	4.762766
1.603462	-3.497526	4.115450
2.290667	-2.493341	3.514022
2.843000	-1.524179	3.484405
3.381618	-0.519099	3.682778
0.709707	-4.512648	5.252426
1.894588	-3.532169	4.413272
2.691892	-2.534567	3.596318
3.305502	-1.572294	3.572371
3.875111	-0.542520	3.834376
0.811074	-4.541779	5.707593
2.176142	-3.594962	4.735846
3.100547	-2.595237	3.805466
3.778686	-1.623381	3.649491
4.357402	-0.567041	3.947628
0.895385	-4.581465	6.075007
2.429302	-3.685646	5.086797
3.500116	-2.671535	4.168455
4.249383	-1.667942	3.711609
4.818130	-0.586216	4.001052
0.958234	-4.628366	6.332618
2.639983	-3.792964	5.460645
3.869540	-2.757164	4.633316
4.694610	-1.704741	3.780217
5.244909	-0.597260	4.009413
1.007607	-4.676352	6.533116
2.821782	-3.902071	5.851299
4.208565	-2.844968	5.109560
5.105557	-1.737806	3.873274
5.633037	-0.603396	3.997846
1.060178	-4.717728	6.783090
3.009468	-3.998152	6.257834
4.535614	-2.927477	5.485371
5.488049	-1.772902	3.975405
5.985254	-0.610838	3.987021
1.120829	-4.747459	7.111969
3.213182	-4.072855	6.674014
4.856483	-2.996529	5.732711

5.839705	-1.804367	4.049855
6.300104	-0.618319	3.976060
1.181476	4.764534	7.463788
3.414892	-4.125383	7.083937
5.158403	-3.045116	5.913859
6.147925	-1.818121	4.073370
6.571119	-0.618886	3.942836
1.237031	-4.771651	7.798032
3.597660	-4.159388	7.454072
5.421687	-3.076211	6.045363
6.402225	-1.817672	4.068341
6.794347	-0.614215	3.894729
1.287868	-4.773517	8.108871
3.753789	-4.180328	7.738738
5.629143	-3.100816	6.084247
6.598078	-1.822740	4.076087
6.969545	-0.613782	3.876076
1.335847	-4.770065	8.406365
3.887427	-4.187689	7.939080
5.788387	-3.120363	6.033329
6.743312	-1.836539	4.091890
7.100925	-0.618885	3.893291
1.380343	-4.757588	8.692988
4.009693	-4.176994	8.106298
5.926838	-3.126877	5.947264
6.855841	-1.844964	4.073387
7.196955	-0.622488	3.908554
1.418288	-4.741713	8.942069
4.117000	-4.155458	8.276031
6.051249	-3.121488	5.857903
6.945918	-1.847094	4.015351
7.266201	-0.624368	3.918864
1.442708	-4.734944	8.099148
4.193457	-4.139350	8.445858
6.145060	-3.113971	5.761927
7.012744	-1.855991	3.946911
7.315059	-0.631471	3.961252
1.458988	-4.737631	9.196679
4.241768	-4.127652	8.569422
6.198636	-3.101961	5.640537
7.049713	-1.871277	3.870728
7.343855	-0.644503	4.039832
1.485913	-4.739009	9.338562
4.282762	-4.103616	8.581776
6.215463	-3.072883	5.472723
7.049676	-1.879035	3.771964
7.349053	-0.657292	4.121128
1.512384	-4.727845	9.534083
4.322141	-4.064172	8.493098
6.205925	-3.033216	5.264323
7.020339	-1.879305	3.674419
7.335420	-0.667522	4.190297
1.534113	-4.709260	9.686838
4.344454	-4.021680	8.378244
6.181026	-3.006324	5.057333
6.981346	-1.885844	3.634459
7.314388	-0.676888	4.253140
1.530358	-4.683385	9.692168
4.320593	-3.978992	8.264985
6.131738	-2.994715	4.920436
6.936393	-1.896880	3.665719
7.285738	-0.682764	4.291927
1.488618	-4.649537	9.478348
4.217610	-3.924848	8.128263
6.031486	-2.976318	4.925601
6.870588	-1.894517	3.731876
7.237266	-0.678613	4.271724
1.407677	-4.600466	9.058414
4.030470	-3.841361	7.961569
5.868225	-2.931890	5.056360

6.769606	-1.871858	3.785543
7.161592	-0.665854	4.205254
1.297853	-4.521377	8.537498
3.784242	-3.708652	7.783470
5.649253	-2.851067	5.199605
6.625515	-1.834891	3.788238
7.059353	-0.653266	4.153174
1.174870	-4.390519	8.033585
3.510476	-3.516583	7.584889
5.390654	-2.728171	5.275394
6.441978	-1.784306	3.742019
6.934771	-0.642650	4.125579
1.056723	-4.182423	7.589902
3.238939	-3.267390	7.330752
5.113470	-2.561832	5.275687
6.232859	-1.713182	3.677997
6.793234	-0.627720	4.084808
0.955146	-3.879495	7.125545
2.990359	-2.974597	7.006394
4.835971	-2.356394	5.220478
6.009928	-1.615678	3.604743
6.637501	-0.603752	4.002564
0.874025	-3.479070	6.521286
2.775566	-2.660190	6.630077
4.571587	-2.122901	5.127680
5.780445	-1.490617	3.510893
6.467932	-0.569554	3.873295
0.813176	-3.011536	5.822964
2.597712	-2.343107	6.230090
4.328599	-1.879779	4.992651
5.551085	-1.346191	3.415300
6.286260	-0.525939	3.695946
0.769364	-2.538474	5.225262
2.454349	-2.036674	5.834766
4.111372	-1.648654	4.809958
5.329940	-1.198431	3.351667
6.096691	-0.474907	3.468687
0.739410	-2.106856	4.824097
2.343574	-1.750180	5.474314
3.926043	-1.437775	4.604167
5.126387	-1.056028	3.295034
5.906671	-0.419813	3.207420
0.721323	-1.737394	4.467951
2.264296	-1.491042	5.030594
3.780204	-1.243745	4.293127
4.950171	-0.920172	3.099696
5.727530	-0.365216	2.871014
0.711416	-1.442436	3.610468
2.211614	-1.271764	3.987052
3.675793	-1.074927	3.438857
4.811247	-0.800959	2.449128
5.575634	-0.318188	2.210059
0.704626	-1.226642	2.332338
2.176830	-1.106135	2.534619
3.607351	-0.949649	2.199572
4.717410	-0.716111	1.540384
5.467402	-0.286387	1.367513
0.698121	-1.072211	1.578030
2.151881	-0.987005	1.703151
3.563600	-0.865654	1.481845
4.660978	-0.665373	1.029264
5.399021	-0.269419	0.896204
0.691701	-0.944879	1.402932
2.131166	-0.888678	1.511553
3.530405	-0.799939	1.317641
4.620999	-0.629568	0.912325
5.348565	-0.258721	0.776353
0.686376	-0.831988	1.158793
2.113796	-0.800020	1.246913
3.502503	-0.739516	1.089337

4.587556	-0.596078	0.752009
5.305357	-0.248652	0.624490
0.683589	-0.743826	0.766720
2.102823	-0.727031	0.823053
3.483390	-0.685371	0.721019
4.563836	-0.563034	0.495465
5.273617	-0.237700	0.401478
0.683325	-0.680430	0.529652
2.098245	-0.669731	0.566478
3.473095	-0.637509	0.497874
4.549912	-0.530428	0.340048
5.253137	-0.225974	0.268904
0.684065	-0.627338	0.480360
2.096314	-0.618785	0.510988
3.466538	-0.591944	0.450332
4.540240	-0.497660	0.305691
5.237512	-0.213689	0.236036
0.684974	-0.572071	0.459595
2.094594	-0.565218	0.485750
3.459999	-0.543514	0.429044
4.530475	-0.462572	0.289133
5.221543	-0.200551	0.217323
0.686044	-0.505111	0.450781
2.092460	-0.500329	0.472521
3.451924	-0.484842	0.418111
4.518447	-0.420085	0.278820
5.202134	-0.184675	0.202180
0.687587	-0.407318	0.545359
2.089310	-0.405613	0.564701
3.440028	-0.399174	0.500711
4.500774	-0.358049	0.328617
5.173813	-0.161602	0.225297
0.341653	-0.173650	0.237312
1.024960	-0.173651	0.237314
1.729382	-0.173649	0.251978
2.454920	-0.173649	0.251980
3.150898	-0.173651	0.231446
3.817315	-0.173652	0.231447
4.415579	-0.161471	0.180911
4.947293	-0.159042	0.177914
0.971298	-0.208440	
0.983378	-0.140244	
0.985952	-0.102582	
0.979721	-0.133556	
0.966228	-0.186684	
0.966594	-0.238917	
0.968302	-0.222768	
0.978386	-0.157731	
0.969249	-0.189668	
0.948043	-0.267343	
0.931722	-0.358843	
0.951627	-0.292522	
0.962735	-0.242486	
0.955350	-0.257250	
0.934412	-0.316894	
0.863685	-0.502916	
0.924528	-0.372829	
0.940277	-0.322245	
0.934199	-0.330419	
0.918822	-0.363688	
0.784734	-0.619269	
0.884371	-0.460547	
0.914343	-0.390012	
0.910447	-0.392686	
0.901142	-0.408068	
0.703238	-0.710504	
0.836948	-0.541904	
0.886695	-0.448855	
0.888770	-0.439470	
0.885395	-0.442288	

0.621731	-0.782814
0.788016	-0.610670
0.855832	-0.504598
0.868657	-0.476977
0.877383	-0.457946
0.542108	-0.839933
0.737764	-0.670427
0.821352	-0.558468
0.850635	-0.507661
0.880751	-0.451626
0.467184	-0.883829
0.681586	-0.727565
0.787432	-0.605212
0.837502	-0.529054
0.894335	-0.425058
0.398260	-0.916995
0.620948	-0.780501
0.757086	-0.643711
0.832998	-0.537568
0.912025	-0.388034
0.335923	-0.941665
0.563200	-0.823865
0.728049	-0.678002
0.839310	-0.530060
0.926678	-0.355481
0.279883	-0.959854
0.511605	-0.857248
0.701962	-0.705975
0.851693	-0.511564
0.938647	-0.326162
0.231625	-0.972680
0.464958	-0.883672
0.684460	-0.723464
0.862728	-0.493874
0.953038	-0.284626
0.194861	-0.980766
0.421698	-0.905533
0.677736	-0.730612
0.872955	-0.477934
0.967706	-0.234663
0.171398	-0.985179
0.381131	-0.923807
0.680578	-0.729156
0.886981	-0.454647
0.976977	-0.198796
0.158343	-0.987377
0.345693	-0.937961
0.689167	-0.722216
0.901611	-0.427650
0.981643	-0.180234
0.150828	-0.988557
0.319131	-0.947514
0.698599	-0.714085
0.909067	-0.413611
0.985665	-0.161713
0.148097	-0.988973
0.299811	-0.953925
0.706744	-0.706569
0.911009	-0.410597
0.989481	-0.140188
0.152074	-0.988363
0.282778	-0.959175
0.713790	-0.699697
0.916887	-0.398019
0.991402	-0.128293
0.158901	-0.987290
0.269256	-0.963068
0.718439	-0.695164
0.927597	-0.372816
0.991790	-0.126530

0.160809	-0.986985
0.265722	-0.964048
0.718301	-0.695557
0.935432	-0.353044
0.992307	-0.123098
0.157288	-0.987550
0.274246	-0.961659
0.715402	-0.698703
0.936557	-0.350434
0.993067	-0.117382
0.154957	-0.987921
0.291301	-0.956608
0.715761	-0.698287
0.931558	-0.363545
0.992824	-0.119571
0.158089	-0.987420
0.309016	-0.951005
0.720668	-0.693156
0.922156	-0.386646
0.991604	-0.129175
0.167541	-0.985844
0.317206	-0.948287
0.724226	-0.689485
0.911339	-0.411544
0.990715	-0.135791
0.184090	-0.982853
0.314691	-0.948997
0.716614	-0.697249
0.902346	-0.430801
0.990277	-0.138655
0.210524	-0.977451
0.309531	-0.950269
0.687919	-0.724908
0.896365	-0.442603
0.988875	-0.147379
0.254075	-0.966816
0.304476	-0.951009
0.639988	-0.766431
0.888335	-0.457509
0.985352	-0.168021
0.323377	-0.945314
0.295374	-0.952430
0.584148	-0.808439
0.868217	-0.493310
0.979048	-0.200285
0.411658	-0.909071
0.281473	-0.954997
0.525099	-0.846730
0.830013	-0.554074
0.969536	-0.241198
0.493231	-0.865430
0.266642	-0.957757
0.461265	-0.882158
0.774624	-0.628411
0.956396	-0.288181
0.541151	-0.833580
0.253107	-0.960630
0.396405	-0.912586
0.704915	-0.705109
0.938657	-0.340862
0.535120	-0.834278
0.239852	-0.964080
0.340858	-0.934642
0.623211	-0.777848
0.914926	-0.399578
0.471568	-0.870056
0.223427	-0.968563
0.297615	-0.949842
0.536995	-0.839817
0.885180	-0.461317

0.372545	-0.917528
0.199224	-0.974690
0.259393	-0.962023
0.462878	-0.883398
0.851519	-0.520677
0.268718	-0.954997
0.167828	-0.981547
0.221970	-0.972176
0.410075	-0.909646
0.813877	-0.577980
0.180036	-0.977647
0.136531	-0.987222
0.188010	-0.979809
0.371136	-0.926622
0.768889	-0.637066
0.115950	-0.988121
0.109861	-0.990821
0.159171	-0.985130
0.317378	-0.939733
0.720559	-0.691626
0.075536	-0.991404
0.086541	-0.992723
0.133476	-0.988978
0.306651	-0.950521
0.684832	-0.727338
0.051111	-0.991746
0.064753	-0.993670
0.109018	-0.991964
0.278853	-0.959363
0.669212	-0.742012
0.033362	-0.992130
0.043830	-0.994576
0.085185	-0.994261
0.252415	-0.966721
0.663507	-0.747177
0.018691	-0.992250
0.025603	-0.994779
0.063779	-0.995442
0.226987	-0.972773
0.657864	-0.752081
0.009429	-0.991519
0.013977	-0.993490
0.048456	-0.994670
0.204239	-0.976824
0.648936	-0.759546
0.005756	-0.990189
0.009193	-0.991095
0.039436	-0.992193
0.184398	-0.978938
0.636395	-0.769680
0.004550	-0.988929
0.007424	-0.989564
0.033183	-0.990861
0.165784	-0.981306
0.621520	-0.781478
0.003633	-0.984695
0.005970	-0.985583
0.026864	-0.987762
0.145608	-0.982656
0.603826	-0.794515
0.002521	-0.973257
0.004178	-0.974804
0.019139	-0.979025
0.120426	-0.981043
0.579843	-0.810280
0.000939	-0.953013
0.001577	-0.955678
0.007956	-0.963307
0.083089	-0.976001
0.539988	-0.834109

0.000000	0.000000
0.000000	0.000000
0.000000	0.000000
0.000000	0.000000
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SEALLOADS V1.1 – PART III

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1 INTRODUCTION

This chapter describes the DIF (DIFfraction) module of the SEALOADS package. The DIF module computes the response function due to the diffracted waves.

The main text of this chapter describes input/output files, their formats and records.

2 INPUT AND OUTPUT FILES

2.1 INPUT FILES

To run DIF, the user needs to provide the following input files:

1. <filename>.ctr main input file containing:
 - Principal ship dimensions and hydrostatics
 - Physical constants
 - Control indices for computing options
 - Time step data
 - Initial conditions
 - Incident wave information.
2. <filename>.data input file from the RAD module containing main ship data and hydrostatics
3. <filename>.msh containing the information on nodes and panels under the waterline

where <filename> is a suitable name string up to 25 characters in length.

Note that RAD, DIF, DAMP and SEALOAD share the same input files: <filename>.ctr and <filename>.msh. The format and description of these two files are given in Sections 3 and 4, PART II. Examples of input files are presented in Appendices III, IV and V, PART II. The format and description of <filename>.data are given in Section 5, Part II and the example of this file is in Appendix VII, Part II. The organization of DIF input/output files is shown in Figure 2.1. **Users must not alter the three input files after running the RAD program.**

2.2 OUTPUT FILES

DIF produces the following output files:

1. <filename>.ki7f Contains the response functions of total forces due to the diffracted waves
2. <filename>.ki7fx Contains the response functions of sea loads acting on a given cross section due to the diffracted waves
3. <filename>.ki7p Contains the response functions of pressures on each panel centroid due to the diffracted waves.

The format and description of output files are given in Section 3.

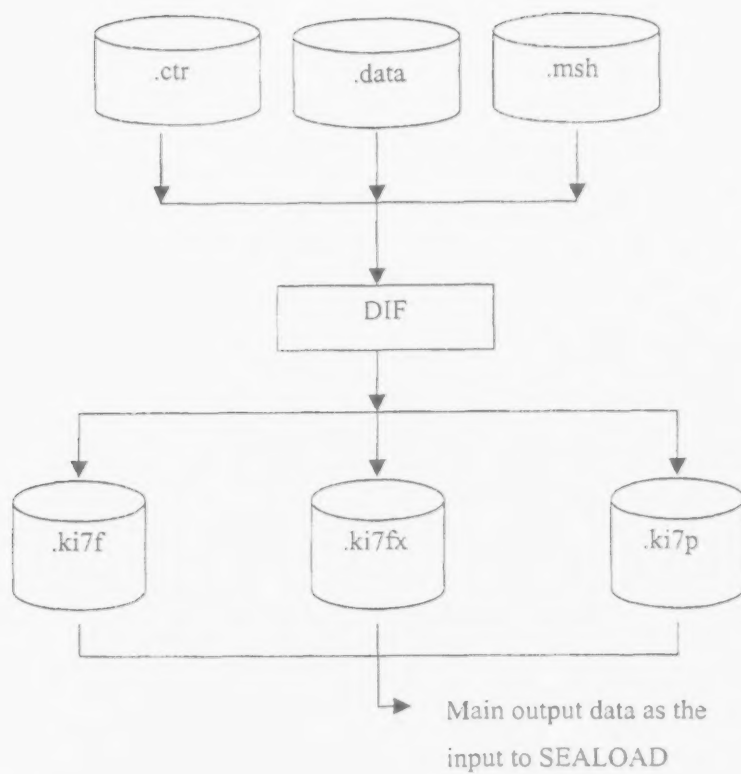


Figure 2.1 Organization of program DIF

3 DESCRIPTION OF OUTPUT FILES

A brief description of the records in the output files <filename>.ki7f, <filename>.ki7fx, and <filename>.ki7p is presented.

3.1 <FILENAME>.KI7F

This file contains the response function of the total force acting on the ship due to diffracted waves. It is an input file to SEALOAD.

Time	Response function
t(1)	Response function $K_{,7}(6)$ at time 0
t(2)	Response function $K_{,7}$ at time $t = dt0$
t(3)	Response function $K_{,7}$ at time $t = 2 \times dt0$
...	...
t(nretar0)	Response function $K_{,7}$ at time $t = nretar0 \times dt0$
t(nretar0+1)	Response function $K_{,7}$ at time $t = (nretar0 + 1) \times dt0$

where dt0 is the time step used in computations for the response functions in RAD and DIF and nretar0 is the number of corresponding time steps.

3.2 <FILENAME>.KI7FX

This file contains the response functions of sea loads acting on the fore-body due to diffracted waves. It is an input file to SEALOAD.

For cross-sections, $i=1, \dots, numxcx$, the following response functions are output:

Time	Response function
t(1)	Response function $K_{i7}^X(6)$ at time 0
t(2)	Response function K_{i7}^X at time $t = dt0$
t(3)	Response function K_{i7}^X at time $t = 2 \times dt0$
...	...
t(nretar0)	Response function K_{i7}^X at time $t = nretar0 \times dt0$
t(nretar0+1)	Response function K_{i7}^X at time $t = (nretar0 + 1) \times dt0$

where dt0 is the time step used in computations for the response functions in RAD and DIF and nretar0 is the number of corresponding time steps.

3.3 <FILENAME>.KI7P

This file contains the response functions of pressure on each panel due to diffracted waves. It is an input file to SEALOAD for the pressure distribution computation. If presctr=0, this file won't be produced.

Time	Response function
t(1)	Response function $K_{i7}^P(Npanel)$ at time $t = 0$
t(2)	Response function K_{i7}^P at time $t = dt0$
t(3)	Response function K_{i7}^P at time $t = 2 \times dt0$
...	...
t(nretar0)	Response function K_{i7}^P at time $t = nretar0 \times dt0$
t(nretar0+1)	Response function K_{i7}^P at time $t = (nretar0 + 1) \times dt0$

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SEALOADS V1.1 – PART IV

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1 INTRODUCTION

This part describes the DAMP module of the SEALOADS package. The DAMP module computes the viscous roll damping coefficient.

The main text describes input/output files and their formats and records.

Examples of output files for a Canadian Patrol Frigate (CPF) are presented in Appendices I and II.

2 INPUT AND OUTPUT FILES

2.1 INPUT FILES

To run DAMP, the user needs to provide the following input files:

- | | |
|--------------------|---|
| 1. <filename>.ctr | main input file containing: <ul style="list-style-type: none">• principal ship dimensions and hydrostatics• physical constants• control indices for options• time step data• initial condition• incident wave information. |
| 2. <filename>.geom | containing panel geometry information. |
| 3. <filename>.b44 | containing roll decay test data and the GZ curve. |
| 4. <filename>.b44f | containing information for computing the roll damping coefficient with empirical formulae. |

where <filename> is a suitable name string up to 25 characters in length.

RAD, DIF, DAMP and SEALOAD share the same input file: <filename>.ctr. The format and description of the file are given in Section 3, PART II. Examples of input files are presented in Appendix III, PART II. The format and description of <filename>.b44 and <filename>.b44f are given in Section 3. Respective examples are presented in Appendices I and II. An example of <filename>.geom is shown in Appendix VIII, Part II.

2.2 OUTPUT FILES

DAMP produces the following output files:

1. <filename>.damp contains viscous roll damping coefficients.

The format and description of output files are given in Section 4 and an example of the output file is given in Appendix III.

The organization of the input/output files is shown in Fig. 2.1.

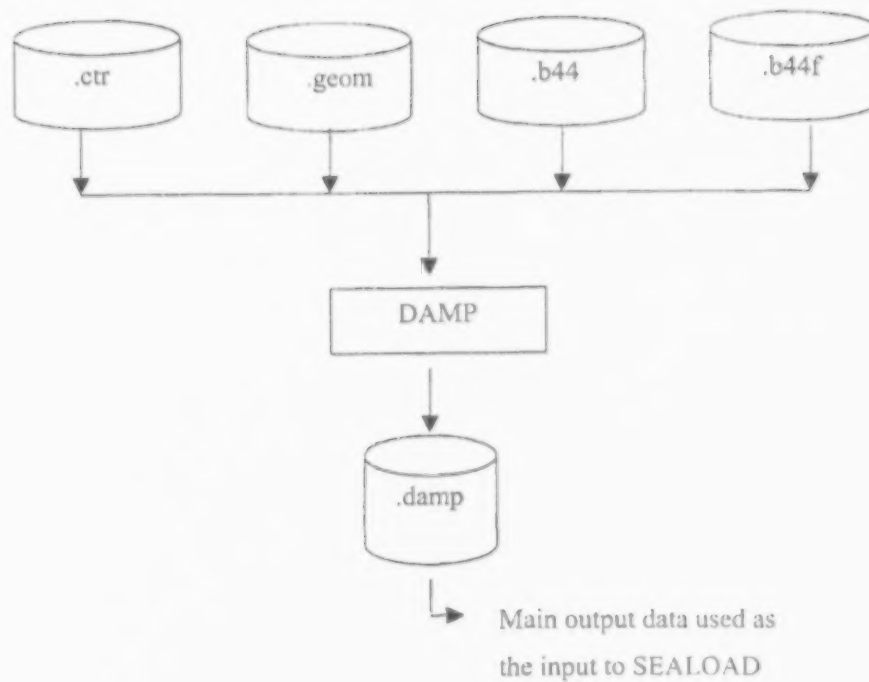


Figure 2.1 Organization of program DAMP

3 FORMAT OF INPUT FILES

The following is the format of the input files <filename>.b44, and <filename>.b44f. The definitions of records for these files are given in Section 4. Comment lines can be introduced by making '#' as the first character of the line. The program does not differentiate between lower and upper case characters. The input records are in the NAMELIST format, where a variable should be followed by '='. Note that space(s) between a variable or a value and '=' does not make any differences.

3.1 FORMAT OF <FILENAME>.B44

period, numdecay, numgz

decayt(i), decayangle(i) i=1, 2, ..., numdecay

gzangle(i), gzvalue(i) i=1, 2, ..., numgz

3.2 FORMAT OF <FILENAME>.B44F

control data for viscous damping computation

&b44controls

ibk

ibe

ibf

iba

ibl

ns

/end{b44controls}

bilge geometry

&bilgegeom

ns0

ns1

bilgeb

ratio1b

/end{bilgegeom}

kinematic viscosity of water

&viscosity

viscoef

/end{viscosity}

sectional parameters - a

&sectionparameter_a

ship_i

ship_s

ship_b

ship_kg

ship_d

/end{sectionparameter_a}

sectional parameter - b

&sectionparameter_b

ship_rhat

ship_a

ship_r

```
ship_rb  
ship_lk  
/end{sectionparameter_b}
```

```
# section parameter - c
```

```
&sectionparameter_c  
ship_g  
ship_ss  
ship_f_r  
ship_a_g  
/end{sectionparameter_c}
```

```
# rudder parameters
```

```
&rudderparameter  
skegspan  
vcg  
rudderspan  
skegangle  
rudderarea  
/end{rudderparameter}
```

```
# appendages
```

```
&appendages  
numapp  
nfcoef  
app_y  
app_z
```

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4 DISCRIPTION OF INPUT FILES

4.1 DESCRIPTION OF <FILENAME>.B44

4.1.1 CONTROL RECORD

period - period of roll, *second*.
 numdecay - number of roll decay test data (maximum 3000).
 numgz - number of GZ curve points (maximum 3000).

4.1.2 ROLLDECAY RECORD

decayt(i) - time, *second*, $i=1, 2, \dots, \text{numdecay}$.
 decayangle(i) - roll angle, *degree*, $i=1, 2, \dots, \text{numdecay}$.

4.1.3 GZCURVE RECORD

gzangle(i) - roll angle, *degree*, $i=1, 2, \dots, \text{numgz}$.
 gzvalue(i) - moment arm, *meter*, $i=1, 2, \dots, \text{numgz}$.

4.2 DESCRIPTION OF <FILENAME>.B44F

4.2.1 CONTROLS RECORD

ibk =1, bilge keel viscous roll damping coefficient will be computed;
 =0, bilge keel viscous roll damping coefficient won't be computed.
 ibe =1, eddy-making viscous roll damping coefficient will be computed;
 =0, eddy-making viscous roll damping coefficient won't be
 computed.
 ibf =1, friction viscous roll damping coefficient will be computed;

	=0, friction viscous roll damping coefficient won't be computed.
iba	=1, appendage (other than bilge keel) viscous roll damping coefficient will be computed; =0, appendage (other than bilge keel) viscous roll damping coefficient won't be computed.
ibl	=1, lifting viscous roll damping coefficient of rudder and skeg will be computed; =0, lifting viscous roll damping coefficient of rudder and skeg will be computed;
ns	- total number of sections (maximum 25)

The above record must not be omitted.

4.2.2 BILGEGEOM RECORD

ns0	- station number of the section where the bilge keel starts.
ns1	- station number of the section where the bilge keel ends.
bilgeb	- bilge keel width, <i>meter</i> .
ratio1b	- bilge width-length ratio.

4.2.3 VISCOSITY RECORD

viscoef	- kinematic viscosity of water, m^2 / s .
---------	---

4.2.4 SECTIONPARAMETER_A RECORD

ship_i(i)	- sectional shape identifier, $i=1, 2, \dots, ns$ =1, for V or U-shaped section, =2, for full-almost rectangular section, =3, triangular section.
-----------	--

- ship_s(i) - wetted surface area of the segment at section i , $meter^2$, $i=1, 2, \dots, ns$.
(see Figure 1)
- ship_b(i) - sectional beam, $meter$, $i=1, 2, \dots, ns$.
- ship_kg(i) - height of ship's CG above the lowest point at each section, $meter$,
 $i=1, 2, \dots, ns$
- ship_d(i) - sectional draught, $meter$, $i=1, 2, \dots, ns$.

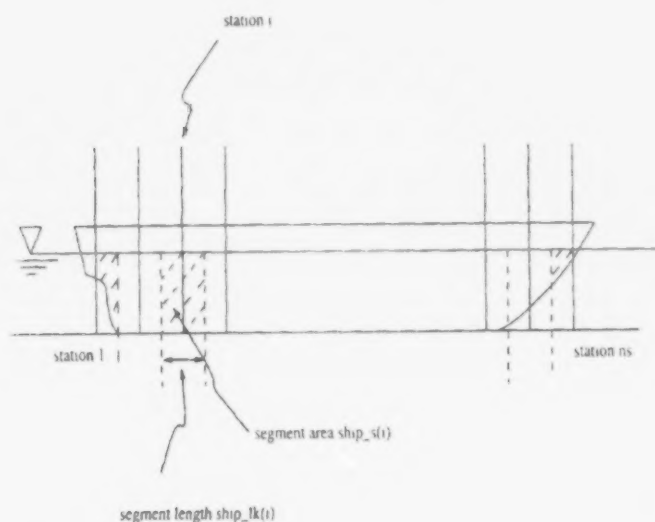


Figure 1. Sectional geometry definition

4.2.5 SECTIONPARAMETER_B RECORD

- ship_rhat(i) - distance from ship's CG to the point where eddies are shed,
in the yz plane, $meter$, $i=1, 2, \dots, ns$.
- ship_a(i) - inclination angle of ship side at the section waterline, $degree$
(Figure 2), $i=1, 2, \dots, ns$.
- ship_r(i) - distance from the CG to the center of the bilge keel at each section,
 $meter$, $i=1, 2, \dots, ns$. If no bilge keel, set the value to zero.

- ship_rb(i) - sectional bilge radius, *meter*, $i=1, 2, \dots, ns$.
- ship_lk(i) - segment length, *meter*, $i=1, 2, \dots, ns$. (Figure 1)

4.2.6 SECTIONPARAMETER_C RECORD

- ship_g(i) - angle between waterlines, from the center of gravity to the bilge keel root and DWL, *radian*, $i=1, 2, \dots, ns$. (Figure 3)
- ship_ss(i) - length of girth from the bilge keel root to DWL, *meter*, $i=1, 2, \dots, ns$. (Figure 2)
- ship_f_r(i) - sectional deadrise, *meter*, $i=1, 2, \dots, ns$. (Figure 2)
- ship_a_g(i) - angle made by the plane of the bilge keel with the straight line passing through CG and the bilge root, *radian*, $i=1, 2, \dots, ns$. (Figure 3)

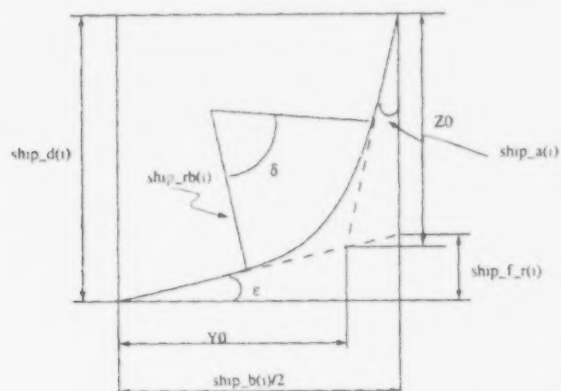


Figure 2. Cross sectional parameters

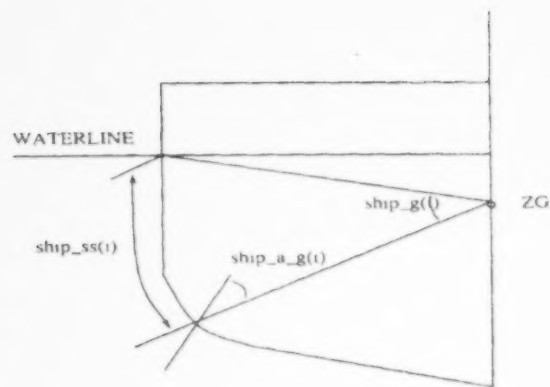


Figure 3. Bilge keel parameters

4.2.7 RUDDERPARAMETER RECORD

- skegspan - skeg span, *meter*. (Figure 4)
- vcg - vertical distance of CG above waterline, *meter*. (Figure 4)
- rudderspan - rudder span, *meter*. (Figure 4)
- skegangle - skeg angular parameter, *radian*. (Figure 4)
- rudderarea - rudder planform area, *meter*².

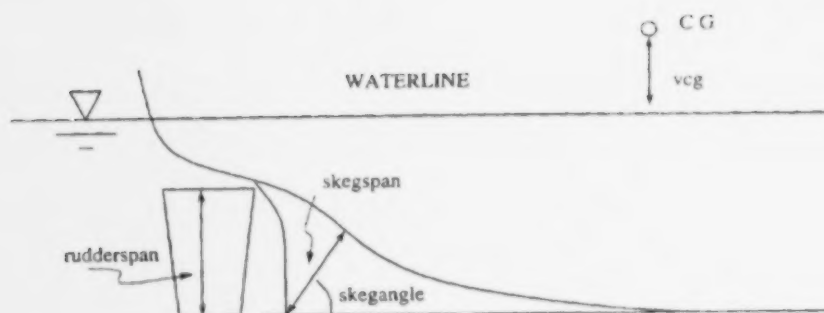


Figure 4. Skeg and rudder parameters

4.2.8 APPENDAGES RECORD

- numapp - total number of appendages (maximum 25).
- nfcoef - normal force coefficient for a flat plate inclined at a large angle to the flow.
- app_y(i) - y-coordinate of appendage *i*, meter, $i=1, 2, \dots, \text{numapp}$. (Figure 5)
- app_z(i) - y-coordinate of appendage *i*, meter, $i=1, 2, \dots, \text{numapp}$. (Figure 5)
- app_g(i) - dihedral angle of appendage *i*, degree, $i=1, 2, \dots, \text{numapp}$. (Figure 5)
- app_c_e(i) - end chord of appendage *i*, meter, $i=1, 2, \dots, \text{numapp}$. (Figure 6)
- app_c_r(i) - root chord of appendage *i*, meter, $i=1, 2, \dots, \text{numapp}$. (Figure 6)
- app_b(i) - span of appendage *i*, meter, $i=1, 2, \dots, \text{numapp}$. (Figure 6)

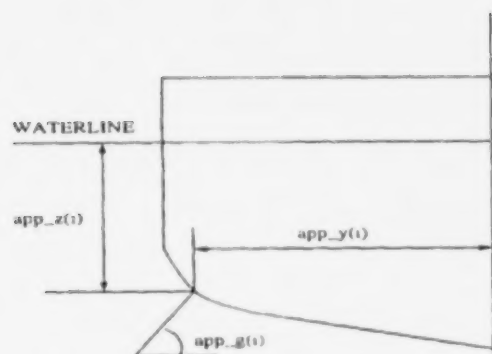


Figure 5. Appendage parameters

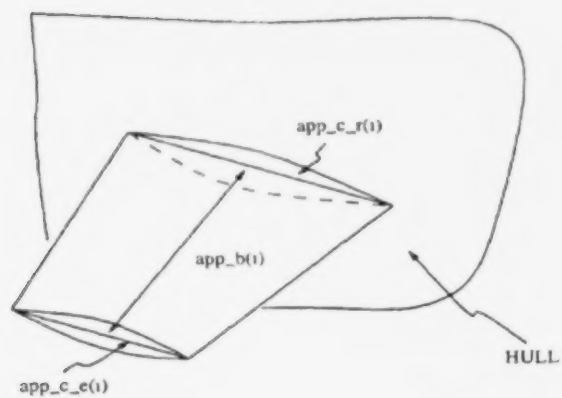


Figure 6. An example of appendage parameters

5 DESCRIPTION OF <FILENAME>.DAMP

The following is a brief description of the records in the output file <filename>.damp. An example of this file is given in Appendix II.

5.1 <FILENAME>.DAMP

dampcoeff(1), dampcoeff(2) - damping coefficients which are described in Part II.

APPENDIX I CAPE.B44

2.14 741 6

1.7800	-19.2410
1.8000	-19.1580
1.8200	-19.0300
1.8400	-18.8300
1.8600	-18.5310
1.8800	-18.1820
1.9000	-17.7610
1.9200	-17.3030
1.9400	-16.8450
1.9600	-16.1330
1.9800	-15.4700
2.0000	-14.7490
2.0200	-13.9860
2.0400	-13.1650
2.0600	-12.3270
2.0800	-11.4410
2.1000	-10.5380
2.1200	-9.5860
2.1400	-8.6320
2.1600	-7.6590
2.1800	-6.6800
2.2000	-5.6940
2.2200	-4.6680
2.2400	-3.6480
2.2600	-2.6520
2.2800	-1.6220
2.3000	- 6200
2.3200	.3750
2.3400	1.3420
2.3600	2.3590
2.3800	3.3210
2.4000	4.2530
2.4200	5.1530
2.4400	6.0630
2.4600	6.9280
2.4800	7.7640
2.5000	8.5840
2.5200	9.3260
2.5400	10.0770
2.5600	10.7570
2.5800	11.3970
2.6000	12.0300
2.6200	12.5480
2.6400	13.0830
2.6600	13.5480
2.6800	13.9530
2.7000	14.3630
2.7200	14.6470
2.7400	14.9090
2.7600	15.1000
2.7800	15.2690
2.8000	15.3960
2.8200	15.4800
2.8400	15.4450
2.8600	15.4140
2.8800	15.2930
2.9000	15.0820
2.9200	14.9580
2.9400	14.7000
2.9600	14.4130

2.9800	14.0000
3.0000	13.7280
3.0200	13.3190
3.0400	12.8570
3.0600	12.2670
3.0800	11.8630
3.1000	11.3120
3.1200	10.7430
3.1400	10.0790
3.1600	9.5190
3.1800	8.8590
3.2000	8.1980
3.2200	7.5060
3.2400	6.7920
3.2600	6.0620
3.2800	5.3590
3.3000	4.6120
3.3200	3.8610
3.3400	3.0990
3.3600	2.3620
3.3800	1.5970
3.4000	.8470
3.4200	.1170
3.4400	- .6250
3.4600	-1.3620
3.4800	-2.0740
3.5000	-2.7710
3.5200	-3.4520
3.5400	-4.1170
3.5600	-4.7690
3.5800	-5.4020
3.6000	-5.9960
3.6200	-6.5710
3.6400	-7.0940
3.6600	-7.6100
3.6800	-8.1130
3.7000	-8.5150
3.7200	-8.9500
3.7400	-9.3010
3.7600	-9.6570
3.7800	-9.9440
3.8000	-10.2190
3.8200	-10.4510
3.8400	-10.6260
3.8600	-10.7670
3.8800	-10.9060
3.9000	-10.9490
3.9200	-10.9630
3.9400	-10.9550
3.9600	-10.9030
3.9800	-10.7930
4.0000	-10.6620
4.0200	-10.4780
4.0400	-10.3040
4.0600	-10.0340
4.0800	-9.7700
4.1000	-9.4510
4.1200	-9.1070
4.1400	-8.6970
4.1600	-8.3310
4.1800	-7.8900
4.2000	-7.4490
4.2200	-6.9970
4.2400	-6.4660
4.2600	-5.9530
4.2800	-5.4260
4.3000	-4.9740
4.3200	-4.3110

4.3400	-3.7420
4.3600	-3.1490
4.3800	-2.7040
4.4000	-1.9630
4.4200	-1.3550
4.4400	-.7630
4.4600	-.1740
4.4800	.4280
4.5000	1.0080
4.5200	1.6080
4.5400	2.1690
4.5600	2.6850
4.5800	3.3190
4.6000	3.8410
4.6200	4.3680
4.6400	4.8850
4.6600	5.3910
4.6800	5.8450
4.7000	6.3030
4.7200	6.7320
4.7400	7.1190
4.7600	7.5000
4.7800	7.8430
4.8000	8.1740
4.8200	8.4580
4.8400	8.7110
4.8600	8.9660
4.8800	9.1590
4.9000	9.3150
4.9200	9.4840
4.9400	9.5720
4.9600	9.6390
4.9800	9.6780
5.0000	9.6870
5.0200	9.6600
5.0400	9.6010
5.0600	9.5170
5.0800	9.3990
5.1000	9.2580
5.1200	9.0770
5.1400	8.8680
5.1600	8.6490
5.1800	8.3900
5.2000	8.0980
5.2200	7.7980
5.2400	7.4560
5.2600	7.1010
5.2800	6.7320
5.3000	6.3480
5.3200	5.9310
5.3400	5.5030
5.3600	5.0770
5.3800	4.6140
5.4000	4.1600
5.4200	3.6910
5.4400	3.2340
5.4600	2.7240
5.4800	2.2450
5.5000	1.7380
5.5200	1.2400
5.5400	.7610
5.5600	.2770
5.5800	-.1940
5.6000	-.7170
5.6200	-1.1730
5.6400	-1.6490
5.6600	-2.1270
5.6800	-2.5690

5.7000	-2.9820
5.7200	-3.3910
5.7400	-3.8220
5.7600	-4.1990
5.7800	-4.5430
5.8000	-4.8950
5.8200	-5.2470
5.8400	-5.5430
5.8600	-5.8060
5.8800	-6.0590
5.9000	-6.3050
5.9200	-6.5180
5.9400	-6.6750
5.9600	-6.8380
5.9800	-7.0780
6.0000	-7.0580
6.0200	-7.1440
6.0400	-7.2140
6.0600	-7.2310
6.0800	-7.2190
6.1000	-7.1820
6.1200	-7.1310
6.1400	-7.0320
6.1600	-6.9230
6.1800	-6.8090
6.2000	-6.6180
6.2200	-6.4310
6.2400	-6.2220
6.2600	-5.9700
6.2800	-5.7180
6.3000	-5.4550
6.3200	-5.1720
6.3400	-4.8570
6.3600	-4.5130
6.3800	-4.2440
6.4000	-3.8390
6.4200	-3.4310
6.4400	-3.0360
6.4600	-2.7280
6.4800	-2.2500
6.5000	-1.8280
6.5200	-1.4090
6.5400	-.9810
6.5600	-.5370
6.5800	-.1190
6.6000	.2980
6.6200	.7210
6.6400	1.1390
6.6600	1.5710
6.6800	1.9880
6.7000	2.3720
6.7200	2.7880
6.7400	3.1710
6.7600	3.5390
6.7800	3.8950
6.8000	4.2440
6.8200	4.5670
6.8400	4.9220
6.8600	5.2070
6.8800	5.4740
6.9000	5.7280
6.9200	5.9960
6.9400	6.2180
6.9600	6.4060
6.9800	6.6020
7.0000	6.7480
7.0200	6.8860
7.0400	6.9900

7.0600	7.0800
7.0800	7.0420
7.1000	7.2000
7.1200	7.2070
7.1400	7.2100
7.1600	7.1920
7.1800	7.1220
7.2000	7.0680
7.2200	6.9630
7.2400	6.8230
7.2600	6.6990
7.2800	6.5230
7.3000	6.3740
7.3200	6.1510
7.3400	5.9270
7.3600	5.6840
7.3800	5.4420
7.4000	5.1540
7.4200	4.8700
7.4400	4.5640
7.4600	4.2600
7.4800	3.9350
7.5000	3.5960
7.5200	3.2560
7.5400	2.8880
7.5600	2.5300
7.5800	2.1420
7.6000	1.7930
7.6200	1.4220
7.6400	1.0410
7.6600	.6850
7.6800	.2990
7.7000	-.0800
7.7200	-.4500
7.7400	-.8220
7.7600	-1.1530
7.7800	-1.5100
7.8000	-1.8450
7.8200	-2.1620
7.8400	-2.4950
7.8600	-2.7920
7.8800	-3.0860
7.9000	-3.4020
7.9200	-3.6430
7.9400	-3.8980
7.9600	-4.1270
7.9800	-4.3670
8.0000	-4.5460
8.0200	-4.7360
8.0400	-4.8910
8.0600	-5.0150
8.0800	-5.1590
8.1000	-5.2670
8.1200	-5.3350
8.1400	-5.3990
8.1600	-5.4160
8.1800	-5.4430
8.2000	-5.4510
8.2200	-5.4280
8.2400	-5.3920
8.2600	-5.3130
8.2800	-5.2050
8.3000	-5.1230
8.3200	-4.9710
8.3400	-4.8480
8.3600	-4.6810
8.3800	-4.5610
8.4000	-4.3050

0.4200	-4.0830
0.4400	-3.8690
0.4600	-3.6110
0.4800	-3.3490
0.5000	-3.0920
0.5200	-2.8180
0.5400	-2.5250
0.5600	-2.2170
0.5800	-1.9330
0.6000	-1.5950
0.6200	-1.2710
0.6400	-.9420
0.6600	-.5940
0.6800	-.2830
0.7000	.0750
0.7200	.3980
0.7400	.7350
0.7600	1.0640
0.7800	1.4070
0.8000	1.7170
0.8200	2.0570
0.8400	2.3570
0.8600	2.6580
0.8800	2.9540
0.9000	3.2500
0.9200	3.5230
0.9400	3.7930
0.9600	4.0230
0.9800	4.2750
9.0000	4.5080
9.0200	4.7140
9.0400	4.9110
9.0600	5.0740
9.0800	5.2690
9.1000	5.3940
9.1200	5.5240
9.1400	5.6310
9.1600	5.7460
9.1800	5.8010
9.2000	5.8640
9.2200	5.8550
9.2400	5.8890
9.2600	5.8960
9.2800	5.8250
9.3000	5.8160
9.3200	5.7610
9.3400	5.6900
9.3600	5.5680
9.3800	5.4730
9.4000	5.3450
9.4200	5.2000
9.4400	5.0160
9.4600	4.8380
9.4800	4.6370
9.5000	4.4090
9.5200	4.2120
9.5400	3.9640
9.5600	3.7610
9.5800	3.4730
9.6000	3.2060
9.6200	2.9400
9.6400	2.6440
9.6600	2.3620
9.6800	2.0720
9.7000	1.7820
9.7200	1.4980
9.7400	1.1780
9.7600	.8730

9.7800	5590
9.8000	.2460
9.8200	-.0390
9.8400	-.3640
9.8500	-.6430
9.8800	-.9240
9.9000	-1.2090
9.9200	-1.4870
9.9400	-1.7620
9.9600	-2.0300
9.9800	-2.2740
10.0000	-2.5400
10.0200	-2.8530
10.0400	-2.9730
10.0600	-3.1520
10.0800	-3.3750
10.1000	-3.6510
10.1200	-3.6930
10.1400	-3.8410
10.1600	-3.9680
10.1800	-4.1000
10.2000	-4.1930
10.2200	-4.2580
10.2400	-4.3170
10.2600	-4.3980
10.2800	-4.4370
10.3000	-4.4310
10.3200	-4.4010
10.3400	-4.3980
10.3600	-4.3510
10.3800	-4.2820
10.4000	-4.2290
10.4200	-4.1170
10.4400	-4.0470
10.4600	-3.8860
10.4800	-3.7560
10.5000	-3.6010
10.5200	-3.4450
10.5400	-3.2560
10.5600	-3.0560
10.5800	-2.8620
10.6000	-2.6490
10.6200	-2.4230
10.6400	-2.2030
10.6600	-1.9360
10.6800	-1.6860
10.7000	-1.4340
10.7200	-1.2500
10.7400	-.9120
10.7600	-.6230
10.7800	-.3380
10.8000	-.0680
10.8200	.2200
10.8400	.5090
10.8600	.7800
10.8800	1.0600
10.9000	1.3310
10.9200	1.5620
10.9400	1.8820
10.9600	2.1310
10.9800	2.3950
11.0000	2.6680
11.0200	2.8840
11.0400	3.1080
11.0600	3.3390
11.0800	3.5730
11.1000	3.7550
11.1200	3.9430

11.1400	4.1100
11.1600	4.2950
11.1800	4.4260
11.2000	4.5640
11.2200	4.6680
11.2400	4.7720
11.2600	4.8850
11.2800	4.9750
11.3000	5.0110
11.3200	4.9960
11.3400	5.1220
11.3600	5.1220
11.3800	5.1420
11.4000	5.1470
11.4200	5.1130
11.4400	5.0600
11.4600	5.0330
11.4800	4.9690
11.5000	4.8870
11.5200	4.8110
11.5400	4.7220
11.5600	4.5880
11.5800	4.4700
11.6000	4.3360
11.6200	4.0630
11.6400	4.0100
11.6600	3.8600
11.6800	3.6900
11.7000	3.4950
11.7200	3.3030
11.7400	3.1040
11.7600	2.8790
11.7800	2.6700
11.8000	2.4360
11.8200	2.2120
11.8400	1.9490
11.8600	1.7500
11.8800	1.5070
11.9000	1.2580
11.9200	1.0190
11.9400	.7520
11.9600	.5390
11.9800	.2980
12.0000	.0540
12.0200	-.1730
12.0400	-.4090
12.0600	-.6110
12.0800	-.8720
12.1000	-1.0740
12.1200	-1.2680
12.1400	-1.4760
12.1600	-1.6290
12.1800	-1.8470
12.2000	-2.0230
12.2200	-2.1800
12.2400	-2.3320
12.2600	-2.4780
12.2800	-2.6010
12.3000	-2.7340
12.3200	-2.8370
12.3400	-2.9350
12.3600	-3.0440
12.3800	-3.0830
12.4000	-3.1380
12.4200	-3.1770
12.4400	-3.2230
12.4600	-3.2150
12.4800	-3.2370

12.5000	-3.2150
12.5200	-3.2150
12.5400	-3.2030
12.5600	-3.1470
12.5800	-3.0860
12.6000	-3.0180
12.6200	-2.9630
12.6400	-2.8630
12.6600	-2.7810
12.6800	-2.6640
12.7000	-2.5450
12.7200	-2.4250
12.7400	-2.2900
12.7600	-2.1860
12.7800	-2.0030
12.8000	-1.8500
12.8200	-1.6900
12.8400	-1.5020
12.8600	-1.3530
12.8800	-1.1620
12.9000	-.9510
12.9200	-.7660
12.9400	-.6190
12.9600	-.4310
12.9800	-.2390
13.0000	-.0470
13.0200	.1280
13.0400	.3250
13.0600	.5100
13.0800	.6860
13.1000	.8520
13.1200	1.0410
13.1400	1.2100
13.1600	1.3890
13.1800	1.5830
13.2000	1.6740
13.2200	1.8380
13.2400	1.9840
13.2600	2.1110
13.2800	2.1770
13.3000	2.3660
13.3200	2.4710
13.3400	2.5760
13.3600	2.6940
13.3800	2.7710
13.4000	2.8440
13.4200	2.8430
13.4400	2.9640
13.4600	3.0130
13.4800	3.0460
13.5000	3.0660
13.5200	3.1020
13.5400	3.0990
13.5600	3.0870
13.5800	3.0310
13.6000	3.0480
13.6200	3.0360
13.6400	2.9700
13.6600	2.9570
13.6800	2.8400
13.7000	2.7910
13.7200	2.7020
13.7400	2.6200
13.7600	2.4980
13.7800	2.4250
13.8000	2.2930
13.8200	2.1750
13.8400	2.0760

13 8600	1.9060
13 8800	1.7530
13 9000	1.6260
13 9200	1.4590
13 9400	1.3220
13 9600	1.0700
13 9800	.9970
14 0000	.8400
14 0200	.6760
14 0400	.4920
14 0600	.3370
14 0800	.1720
14 1000	.0050
14 1200	-.1530
14 1400	-.3370
14 1600	-.4900
14 1800	-.6370
14 2000	-.7860
14 2200	-.9340
14 2400	-1.0730
14 2600	-1.2360
14 2800	-1.3500
14 3000	-1.4640
14 3200	-1.5760
14 3400	-1.6950
14 3600	-1.7800
14 3800	-1.8810
14 4000	-1.9720
14 4200	-2.0470
14 4400	-2.1270
14 4600	-2.1850
14 4800	-2.2230
14 5000	-2.2610
14 5200	-2.3110
14 5400	-2.3090
14 5600	-2.3220
14 5800	-2.3230
14 6000	-2.3120
14 6200	-2.2880
14 6400	-2.2850
14 6600	-2.2270
14 6800	-2.1820
14 7000	-2.0910
14 7200	-2.0560
14 7400	-1.9880
14 7600	-1.9030
14 7800	-1.8500
14 8000	-1.7250
14 8200	-1.6310
14 8400	-1.5100
14 8600	-1.3990
14 8800	-1.2650
14 9000	-1.2210
14 9200	-1.0100
14 9400	-.8710
14 9600	-.7170
14 9800	-.6490
15 0000	-.4440
15 0200	-.2940
15 0400	-.1510
15 0600	.0000
15 0800	.1430
15 1000	.3100
15 1200	.4750
15 1400	.6150
15 1600	.7640
15 1800	.9200
15 2000	1.0430

15.2200	1.2100
15.2400	1.3590
15.2600	1.4750
15.2800	1.6200
15.3000	1.7260
15.3200	1.8500
15.3400	1.9630
15.3600	2.0720
15.3800	2.1640
15.4000	2.2740
15.4200	2.3540
15.4400	2.3540
15.4600	2.4920
15.4800	2.5680
15.5000	2.6200
15.5200	2.6700
15.5400	2.6880
15.5600	2.7320
15.5800	2.7620
15.6000	2.7490
15.6200	2.7370
15.6400	2.7560
15.6600	2.7230
15.6800	2.7170
15.7000	2.6830
15.7200	2.6300
15.7400	2.5850
15.7600	2.5440
15.7800	2.4970
15.8000	2.3920
15.8200	2.3440
15.8400	2.2620
15.8600	2.1750
15.8800	2.0890
15.9000	1.9820
15.9200	1.8780
15.9400	1.7870
15.9600	1.6650
15.9800	1.5390
16.0000	1.4220
16.0200	1.3010
16.0400	1.1540
16.0600	.9150
16.0800	.8870
16.1000	.7580
16.1200	.6200
16.1400	.4910
16.1600	.3830
16.1800	.2270
16.2000	.0820
16.2200	-.0420
16.2400	-.1530
16.2600	-.2960
16.2800	-.4250
16.3000	-.4970
16.3200	-.6420
16.3400	-.7540
16.3600	-.8590
16.3800	-.9680
16.4000	-1.0270
16.4200	-1.1260
16.4400	-1.2580
16.4600	-1.2960
16.4800	-1.3550
16.5000	-1.3840
16.5200	-1.4410
16.5400	-1.4990
16.5600	-1.5190

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APPENDIX II CPF.B44F

```

# input data of CPF for estimation of roll damping coefficients

# control data

$b44controls
IBK=1
ibe=1
ibf=1
iba=0
ibl=1
ns=21
/end{b44controls}

# bilge geometry

$bilgegeom
ns0=6
nsl=14
bilgeb=0.8
ratio1b=0.01606
/end{bilgegeom}

# kinematic viscosity of water

$viscosity
viscoef=1.14e-06
/end{viscosity}

# sectional parameter - a

$sectionparameter_a
ship_1 = 3 3 3 3 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 3 3 3
ship_s = 0.0 74.07 82.09 92.13 104.24 115.14 118.72 122.43 124.29 124.29
      124.06 122.09 118.15 111.72 103.33 93.47 83.93 74.26 61.42 61.37 0.0
ship_b = 0.000 11.61 12.35 13.02 13.62 14.13 14.52 14.78 14.89 14.89
      14.80 14.53 14.04 13.24 12.11 10.66 8.89 6.85 4.67 2.51 0.0
ship_kg= 1.87 2.83 3.53 4.62 5.98 6.50 6.50 6.50 6.50 6.50
      6.50 6.50 6.50 6.50 6.50 6.50 6.50 6.50 6.37 1.87
ship_d = 0.37 1.33 2.03 3.12 4.48 5.00 5.00 5.00 5.00 5.00
      5.00 5.00 5.00 5.00 5.00 5.00 5.00 5.00 4.87 0.37
/end{sectionparameter_a}

# sectional parameters - b

$sectionparameter_b
ship_rhat = 1.87 2.83 3.53 4.62 5.98 6.90 7.26 7.52 7.61 7.66
      7.66 7.52 6.86 6.53 6.50 6.50 6.50 6.50 6.50 6.37 1.87
ship_a = 0.00 38.7 32.6 25.8 21.0 13.0 8.00 7.00 4.00 4.00
      6.00 7.50 9.00 14.0 19.0 29.8 31.6 28.5 21.4 18.9 0.00
ship_r = 0.06 0.06 0.06 0.06 0.06 7.11 7.61 7.86 7.96 8.06
      8.06 7.86 7.26 6.88 0.06 0.06 0.06 0.06 0.06 0.06 0.06
ship_rb = 0.00 0.00 0.00 0.00 0.00 2.50 2.66 2.60 2.73 2.80
      2.86 2.80 2.70 2.50 0.00 0.00 0.00 0.00 0.00 0.00 0.00
ship_lk = 3.113 6.225 6.225 6.225 6.225 6.225 6.225 6.225 6.225 6.225
      6.225 6.225 6.225 6.225 6.225 6.225 6.225 6.225 6.310 3.113
/end{sectionparameter_b}

# sectional parameters - c

$sectionparameter_c
ship_g = 0.419 0.419 0.419 0.419 0.419 0.419 0.419 0.422 0.427 0.416 0.416
      0.419 0.410 0.401 0.383 0.383 0.383 0.383 0.383 0.383 0.383

```

```

ship_ss = 0.000 0.000 0.000 0.000 0.000 3.440 3.590 3.710 3.750 3.770
          3.710 3.630 3.420 2.990 0.000 0.000 0.000 0.000 0.000 0.000 0.000
ship_f_r = 0.000 0.000 0.000 0.000 0.000 1.234 1.271 1.292 1.304 1.304
          1.294 1.273 1.227 1.153 0.000 0.000 0.000 0.000 0.000 0.000 0.000
ship_a_g = 0.262 0.262 0.262 0.262 0.262 0.262 0.262 0.262 0.261 0.260 0.260
          0.253 0.250 0.250 0.250 0.250 0.250 0.250 0.250 0.250 0.250 0.250
/end{sectionparameter_c}

# rudder parameters

&rudderparameter
skegspan = 5.2
vcg      = 1.138
rudderspan = 5.10
skegangle = 0.96666
rudderarea = 19.0
/end{rudderparameter}

# appendages

&appendages
numapp = 0
nfcoef = 0.0
/end{appendages}

```

APPENDIX III CPF.DAMP

25587226. 81917248.

PART V KERNEL PROGRAM: SEALOAD

SEALOADS V1.1 – PART V

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1 INTRODUCTION

This part of the User's Guide describes the use of the program SEALOAD. The main program SEALOAD calculates the exciting forces, sea loads and pressure distribution in the time domain. The radiation and diffraction forces are computed from the response functions, which are calculated in RAD and DIF. The nonlinear Froude-Krylov forces are computed at the instantaneous position using a 3-D panel method. Viscous damping, resistance, propeller thrust, rudder and maneuvering forces are also included. The SEALOAD program gives output in terms of sea loads acting on cross-sections and the pressure distribution over the ship hull.

The main text of this chapter describes the input/output files and their formats and records.

The theoretical background for computing resistance, cross-flow drag, propeller thrust, maneuvering force, rudder force and slamming force is presented in Appendices I to V.

Appendices VI and VII give examples of two input files for a Canadian Patrol Frigate (CPF). Examples of three output files for CPF are given in Appendices VI to X.

2 INPUT AND OUTPUT FILES

2.1 INPUT FILES

To run SEALOAD, the following input files must be available:

1. <filename>.ctr main input file containing:
 - principal ship dimensions and hydrostatics
 - physical constants
 - control indices for computing options
 - time step data
 - initial conditions
 - incident wave information.
2. <filename>.msh containing the information on node and panels under the waterline.
3. <filename>.data containing the main ship data, computed hydrostatics and mass distribution. This is an output file from RAD.
4. <filename>.dmp containing the viscous roll damping coefficients.
5. <filename>.hull containing the information on nodes and panels on the hull, up to the top of the superstructure.
6. <filename>.otherf containing the information for computation of resistance, cross flow, thrust, rudder force and maneuvering forces.
7. <filename>.presxyz containing locations where pressures will be computed.
8. <filename>.adms containing the data of added mass, damping and restoring forces. This is an output file from RAD.
9. <filename>.kijf containing the ship response function due to the radiated waves. This is an output file from RAD.
10. <filename>.kijfx containing the response function of sea loads acting on a cross-section due to the radiated waves. This is an output file from RAD.

- 11. <filename>.kijp containing the response function of pressure on each panel due to the radiated waves. This is an output file from RAD.
- 12. <filename>.ki7f containing the ship response function due to the diffracted waves. This is an output file from DIF.
- 13. <filename>.ki7fx containing the response function of sea loads acting on a cross-section due to the diffracted waves. This is an output file from DIF.
- 14. <filename>.ki7p containing the response function of pressure on each panel due to the diffracted waves. This is an output file from DIF.

where <filename> is a suitably named string up to 25 characters in length.

Note that RAD, DIF, DAMP and SEALOAD share the same input files - <filename>.ctr and <filename>.msh. The format and description of these two files is given in Sections 3 and 4, PART II. Sample input files are presented in Appendices III and IV, PART II.

The files <filename>.data, <filename>.adms, <filename>.kijf, <filename>.kijfx, <filename>.kijp, <filename>.ki7f, <filename>.ki7fx, <filename>.ki7p, are the output files from RAD and DIF. Their formats and descriptions are presented in PART II and PART III. <filename>.damp is the output from DAMP. Its format and descriptions are in PART IV.

The user must provide the input files - <filename>.otherf and <filename>.hull. The format and description of these two files is presented in Section 3 and 4. Examples are given in Appendices VI to VIII.

The organization of input/output files for SEALOAD is shown in Figure 2.1.

2.2 OUTPUT FILES

With a correct input and a successful execution of the program, the following output files are produced:

- | | |
|----------------------|--|
| 1. <filename>.wave | Contains incident waves for each time step at the origin of either the space-fixed coordinate system or the steady-moving coordinate system. |
| 2. <filename>.wspct | Contains theoretical wave spectrum. |
| 3. <filename>.wspcn | Contains estimated wave spectrum. |
| 4. <filename>.chkf | Contains a display of information on the components of the exciting forces. |
| 5. <filename>.motion | Contains displacements of ship motions for each time step. |
| 6. <filename>.vel | Contains velocities of ship motions for each time step. |
| 7. <filename>.acc | Contains accelerations of ship motions for each time step. |
| 8. <filename>.fx | Contains sea loads acting on the given cross section for each time step. |
| 9. <filename>.pres | Contains pressure distributions on the panels under the waterline for each time step. |

The format and description of the output files is given in Section 5 and examples of three output files are presented in Appendices IX to XI.

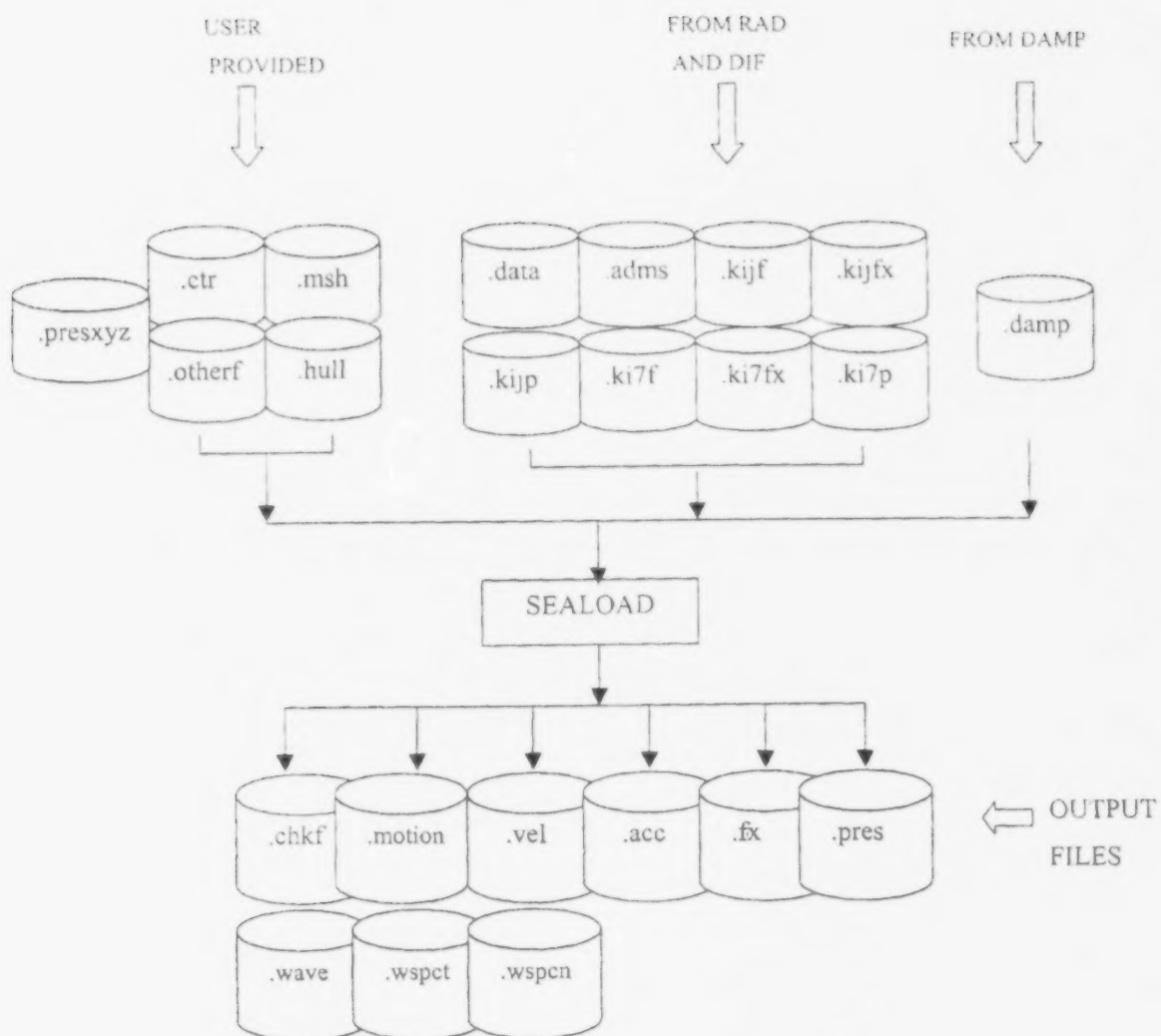


Figure 2.1 Organization of input/output files for SEALOAD

3 FORMAT OF INPUT FILES

The following are the format of the input files `<filename>.otherf`, `<filename>.hull` and `<filename>.presxyz`. Definitions of the records in these files are given in Section 4. Comment lines can be introduced by making '#' as the first character of the line. The program does not differentiate lower or upper case characters.

3.1 FORMAT OF <FILENAME>.OTHERF

Options for the computation of resistance, cross-flow drag, propeller thrust, rudder
force, maneuvering force and slamming force.

&inputforcecontrol

```
resisctr
crossetr
propctr
maneuctr
rudderctr
/
```

Resistance data from experiments

&resisdata

```
numdata
uspeed(1),    uspeed(2),    ...,    uspeed(numdata-1),    uspeed(numdata)
resistance(1), resistance(2), ..., resistance(numdata-1), resistance(numdata)
/end{resisdata}
```

Measured cross flow drag

&crossflow

numcross

crossspeed(1), crossspeed(2), ..., crossspeed(numcross)

crossdrag(1), crossdrag(2), ..., crossdrag(numcross)

/end{crossflow}

Sectional geometry information for estimation of cross flow drag

&crossection

nsection

xcross(1), xcross(2), ..., xcross(nsection-1), xcross(nsection)

zcross(1), zcross(2), ..., zcross(nsection-1), zcross(nsection)

/end{crossection}

Wake fraction and thrust deduction fraction

&wake

wakef

thrustdf

/end{wake}

Propeller geometry data

&propeller

diameter

rpm

/end{propeller}

Measured thrust and torque coefficients of propeller: K_T - K_Q ~ J chart

&prophyd

numkt

kt(1), kt(2), ..., kt(numkt-1), kt(numkt)

kq(1), kq(2), ..., kq(numkt-1), kq(numkt)

jt(1), jt(2), ..., jt(numkt-1), jt(numkt)

/end{prophyd}

Maneuvering coefficients

&maneuver

ycoeff(1), ycoeff(2), ..., ycoeff(5), ycoeff(6)

ncoeff(1), ncoeff(2), ..., ncoeff(5), ncoeff(6)

/end{maneuver}

Rudder geometry data

&ruddergeo

gap

rudwidth

aspectratio

xrudc

zrudc

rudarea

/end{ruddergeo}

Data for autopilot

&autopilot

bias

```
gainangle  
gainrate  
threshold  
rudlim  
/end{autopilot}
```

3.2 FORMAT OF <FILENAME>.HULL

```

nodenum, npanel
1, x(1), y(1), z(1)
2, x(2), y(2), z(2)
...
nodenum-1, x(nodenum-1), y(nodenum-1), z(nodenum-1)
nodenum, x(nodenum), y(nodenum), z(nodenum)
1, nodes(1,1), nodes(2,1), nodes(3,1), nodes(4,1)
2, nodes(1,2), nodes(2,2), nodes(3,2), nodes(4,2)
...
npanel-1, nodes(1,npanel-1), nodes(2,npanel-1), nodes(3,npanel-1), nodes(4,npanel-1)
npanel, nodes(1,npanel), nodes(2,npanel), nodes(3,npanel), nodes(4,npanel)

```

3.3 FORMAT OF <FILENAME>.PRESXYZ

```

numpres
x(1), y(1), z(1)
x(2), y(2), z(2)
...
x(numpres-1), y(numpres-1), z(numpres-1)
x(numpres), y(numpres), z(numpres)

```

4 DESCRIPTION OF INPUT FILES

4.1 DESCRIPTION OF <FILENAME>.OTHERF

4.1.1 INPUTFORCECONTROLS RECORDS

- resisctr - options for the resistance computation. Appendix I presents the theoretical background for the resistance computation.
 = 0, resistance won't be computed in SEALOAD
 = 1, resistance will be computed from the input test data
 = 2, resistance will be computed from empirical formulae
- crossctr - options for the cross-flow drag computation. Appendix II gives the theoretical background.
 = 0, cross-flow drag won't be computed in SEALOAD
 = 1, cross-flow drag will be computed from the input test data
 = 2, cross-flow drag will be computed from empirical formulae
- propctr - options for the propeller thrust computation. Appendix III gives the theoretical background.
 = 0, propeller thrust is equal to the calm water resistance at the input forward speed
 = 1, propeller thrust will be computed from the $K_T - K_Q - J$ chart input by the user
- maneuctr - options for the maneuvering force computation. Appendix IV presents the theoretical background.
 = 0, maneuvering force won't be computed
 = 1, maneuvering force will be computed from the hydrodynamic derivatives provided by the user
 = 2, the maneuvering force will be computed from the hydrodynamic derivatives obtained from empirical formulae
- rudderctr - options for the rudder force computation. The theoretical background is given in Appendix V.

- = 0, rudder force won't be computed
- = 1, rudder force will be computed from the rudder geometry provided by the user

- slamctr - options for the slamming force computation, theoretical background is presented in Appendix VI.
- = 0, slamming forces won't be computed
 - = 1, slamming forces will be computed.

The above record must not be omitted.

4.1.2 RESISDATA RECORD

This record contains the calm water resistance from experiments. The computational technique is presented in Appendix I.

If resisctr $\neq$ 1, this record can be omitted.

- numdata - number of test data, 50 maximum.
- uspeed - forward speeds, m/s . Uspeed(1), uspeed(2), ..., uspeed(numdata).
- resistance - calm water resistance, *Newton*, corresponding to the given forward speeds. resistance(1), resistance(2), ..., resistance(numdata).

4.1.3 CROSSFLOW RECORDS

This record contains the measured cross-flow drag, referring to Appendix II for the cross-flow drag computation.

If crossctr $\neq$ 1, this record can be omitted.

- numcross - number of test data, 50 maximum.

- crossspeed - transverse speeds of flow, m/s . crossspeed(1), crossspeed(2), ..., crossspeed(numcross).
- crossdrag - measured cross-flow drag, *Newton*, corresponding to transverse speeds, crossspeed. crossdrag(1), crossdrag(2), ..., crossdrag(numcross).

4.1.4 CROSSSECTION RECORD

This record contains the sectional geometry for cross-flow drag computation (see Appendix II for the theoretical background).

If crossctr $\neq 2$, this record can be omitted.

- nsection - number of cross sections (50, maximum). It can be equal to the number of stations.
- xcross(i) - x-coordinate of the i th cross-section, *meter*, $i=1, 2, \dots, nsection$ (see Figure 4.1). All sections must be equally spaced.
- zcross(i) - draft at the i th cross-section, *meter*, $i=1, 2, \dots, nsection$ (see Figure 4.1)

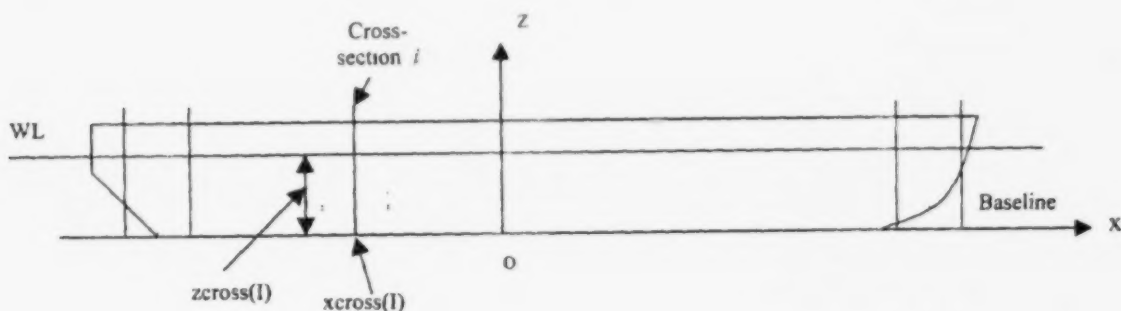


Figure 4.1 Sectional geometry for cross-flow drag computation

4.1.5 WAKE RECORD

If $\text{propctr} \neq 1$, this record can be omitted.

wakef - wake fraction
 thrustdf - thrust deduction fraction

4.1.6 PROPELLER RECORDS

If $\text{propctr} \neq 1$, this record can be omitted.

diameter - diameter of the propeller, *meter*.
 rpm - revolutions per minute (RPM) of the propeller

4.1.7 PROPHYD RECORD

If $\text{propctr} \neq 1$, this record can be omitted.

numkt - number of test data points (50, maximum)
 kt - thrust coefficients. $kt(1)$, $kt(2)$, ..., $kt(\text{numkt})$.
 kq - torque coefficients. $kq(1)$, $kq(2)$, ..., $kq(\text{numkt})$.
 jt - advancing ratio. $jt(1)$, $jt(2)$, ..., $jt(\text{numkt})$.

4.1.8 MANEUVER RECORDS

If $\text{maneuctr} \neq 1$, this record can be omitted.

ycoeff - hydrodynamic derivatives for maneuvering force, $ycoeff(1)$, $ycoeff(2)$, ..., $ycoeff(5)$, $ycoeff(6)$. Definitions of derivative coefficients are presented in Appendix IV.

ncoeff - hydrodynamic derivatives for maneuvering moment.
 Definitions of these derivatives are given in Appendix IV.

4.1.9 RUDDERGEOMETRY RECORDS

These records contain information of rudder geometry for computing rudder forces. The theoretical background is presented in Appendix V. The geometry of the rudder is shown in Figure 4.2.

If rudderctr $\neq$ 1, these records can be omitted.

gap	- distance, <i>meter</i> , from the leading edge of rudder to the hull.
rudwidth	- rudder width, <i>meter</i> .
aspectratio	- aspect ratio of the rudder defined as the ratio of rudder height to rudder width.
xrudc	- horizontal distance, <i>meter</i> , from the center of gravity of ship to the center of pressure of rudder.
zrudc	- vertical distance, <i>meter</i> , from the center of gravity of ship to the center of pressure of rudder.
rudarea	- rudder planform area, <i>meter</i> ² .

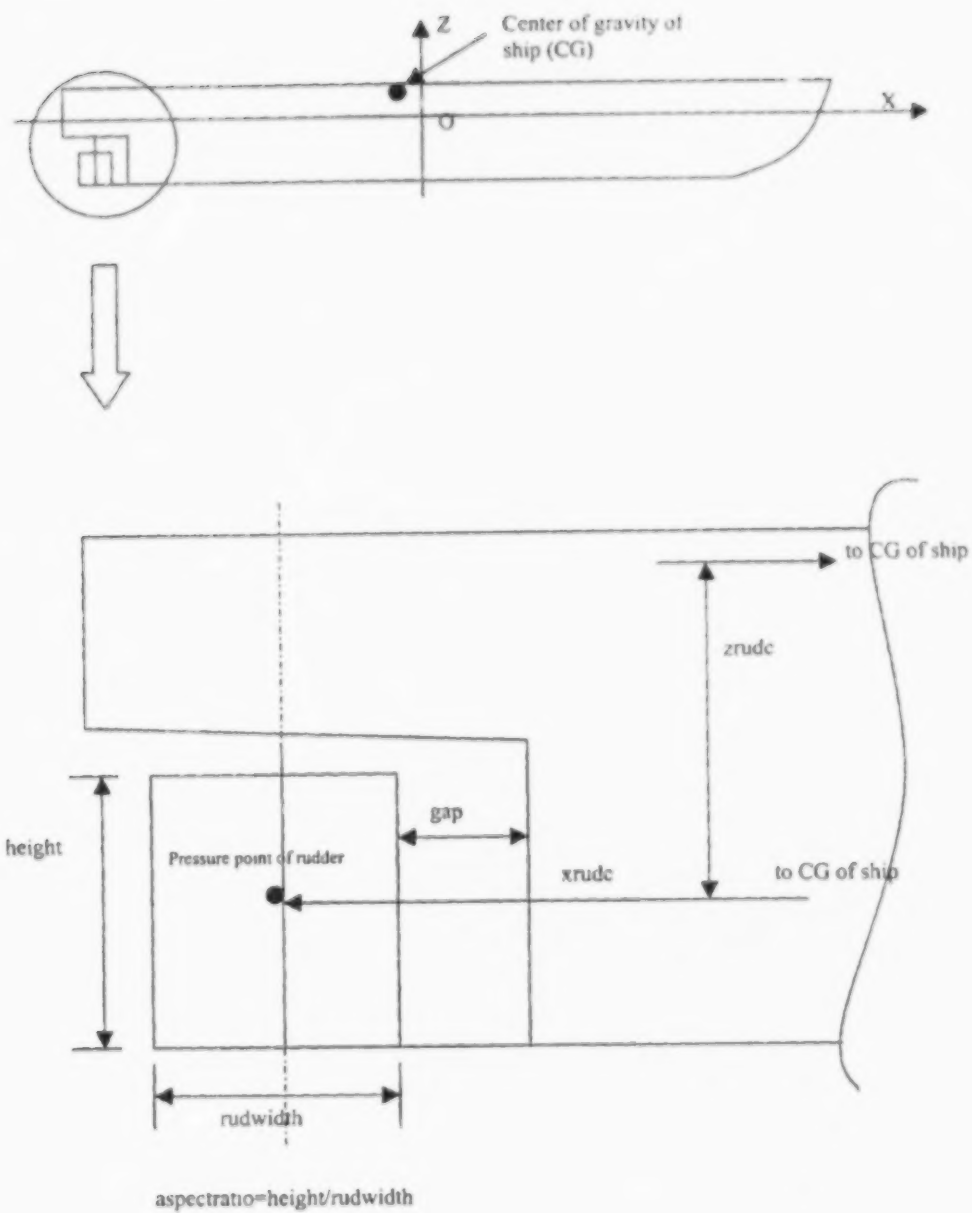


Figure 4.2 Rudder geometry

4.1.10 AUTOPILOT RECORDS

These records contain information for auto-pilot controls. The theoretical background is presented in Appendix V.

If rudderctr $\neq$ 1, the following records can be omitted.

bias	- constant bias angle of rudder, <i>degree</i> .
gainangle	- gain of yaw angle
gainrate	- gain of yaw rate
threshold	- threshold angle of yaw, <i>degree</i> , beyond which the rudder will be activated.
rudlim	- maximum rudder angle, <i>degree</i> .

4.2 DESCRIPTION OF <FILENAME>.HULL

The hull surface on the port side up to the superstructure is discretized into a number of quadrilateral panels for nonlinear Froude-Krylov force computation. This file contains the information on nodes and panel connectivity.

RECORD 1 – NODENUM, NPANEL

NODENUM - number of nodes on the port side of hull (10000 maximum)
 NPANEL - number of panels on the port side of hull (10000 maximum)

RECORD 2 – NO(I), X(I), Y(I), Z(I)

NO(I) - number identifying the *i*th node point
 X(I), Y(I), Z(I) - coordinates of the *i*th node point. The coordinates are with respect to a right-handed coordinate system with the origin at the intersection of the centerline and the design waterline the midship section (see Figure 4.1, PART II).

Repeat above record for $I=1, 2, \dots, \text{NODENUM}$.

RECORD 3 – NO(I), PANEL(1,I), PANEL(2,I), PANEL(3,I), PANEL(4,I)

NO(I) - number identifying the *i*th panel.
 PANEL(1,I) - first node of the *i*th panel.
 PANEL(2,I) - second node of the *i*th panel.
 PANEL(3,I) - third node of the *i*th panel.
 PANEL(4,I) - fourth node of the *i*th panel.

Repeat above record for $I=1, 2, \dots, \text{NPANEL}$.

The input nodes in each panel must be entered in a sequence such that the normal direction of the panel points to the inside of the hull as if the panel is viewed from inside of the hull (see Figure 4.4, PART II). *↖ Counter-clockwise from inside hull.*

4.3 DESCRIPTION OF <FILENAME>.PRESXYZ

Users only need to prepare this file if presctr = 1 and outpres = 1.

RECORD 1 - NUMPRES

NUMPRES - the number of points where pressures will be computed. (maximum 700)

RECORD 2 - X(I), Y(I), Z(I)

X(I), Y(I), Z(I) - coordinates of the *i*th point. The coordinates are with respect to a ship-fixed coordinate system.

Repeat above record for $I=1, 2, \dots, \text{NUMPRES}$.

5 DESCRIPTION OF OUTPUT FILES

The following is a brief description of the records in the output files <filename>.wave, <filename>.wspct, <filename>.spcn, <filename>.chkf, <filename>.motion, <filename>.vel, <filename>.acc, <filename>.fx, <filename>.pres.

3.4 <FILENAME>.WAVE

This file contains the incident waves at each time step. If **outwave=1**, the output incident wave elevations are at the origin of the space-fixed coordinate system; If **outwave=0**, the output incident waves are at the origin of the steady-moving coordinate system. The format of this file is as follows:

```

1          t(1),   elevation(1)
2          t(2),   elevation(2)
           ...,   ...
numstep-1  t(numstep-1), elevation(numstep-1)
numstep    t(numstep),  elevation(numstep)
```

where numstep is the total number of time steps. An example of this file is shown in Appendix II.

3.3 <FILENAME>.WSPCT

This file contains the theoretical wave spectrum of irregular waves (if **wavetype** $\neq$ 0 or 6). The format is as follows:

```

1          Frequency(1) (Hz),   spectrum(1) (m2/Hz)
2          Frequency(2),        spectrum(2)
           ...,                 ...
```

n _{spec} -1	Frequency(n _{spec} -1),	spectrum(n _{spec} -1)
n _{spec}	Frequency(n _{spec}),	spectrum(n _{spec})

where n_{spec} is the number of total frequencies.

3.4 <FILENAME>.WSPCN

This file contains the estimated wave spectrum of irregular waves (if wavetype ≠ 0 or 6) generated by the numerical method. The format is as follows:

1	Frequency(1) (Hz),	spectrum(1) (m ² /Hz)
2	Frequency(2),	spectrum(2)
...	...	...
n _{spec} -1	Frequency(n _{spec} -1),	spectrum(n _{spec} -1)
n _{spec}	Frequency(n _{spec}),	spectrum(n _{spec})

where n_{spec} is the number of total frequencies.

5.5 <FILENAME>.CHKF RECORDS

This file contains the exciting force components at each 10 time steps as follows:

- Total exciting forces, F_{tot}(6,n).
- Radiation force, F_{rad}(6,n)
- Diffraction force, F_{dif}(6,n)
- Froude-Krylov force, F_K(6,n)
- Restoring force, F_{res}(6,n)
- Damping force, F_{dmp}(6,n)
- Slamming force, F_{slam}(6,n)

where n is the total number of time steps (=numstep/10).

In general, the output forces are nondimensionalized as follows:

$$F_i (i = 1,2,3): \quad F_i / \rho g L B A$$

$$F_i (i = 4,5,6): \quad F_i / \rho g L^2 B A$$

where ρ is the density of water; g is the acceleration due to gravity; L is the characteristic length of the ship ($=L_{pp}$, length between perpendiculars); B is the beam of the ship; and A is the wave amplitude. $F_i (i = 1,2,3)$ are the shear forces in x , y , and z directions. $F_i (i = 4,5,6)$ are the bending moments about the x , y , and z -axis, respectively.

The format of this file is given as below:

Record	Description			
1.	Time (step=1)			
	Ftot(1,1),	Ftot(2,1),	...,	Ftot(6,1),
	Frad(1,1),	Frad(2,1),	...,	Frad(6,1),
	Fdif(1,1),	Fdif(2,1),	...,	Frad(6,1),
	FK(1,1),	FK(2,1),	...,	FK(6,1),
	Fres(1,1),	Fres(2,1),	...,	Fres(6,1),
	Fdmp(1,1),	Fdmp(2,1),	...,	Fdmp(6,1),
	Fslam(1,1),	Fslam(2,1),	...,	Fslam(6,1)
2.	Time (step=2)			
	Ftot(1,2),	Ftot(2,2),	...,	Ftot(6,2),
	Frad(1,2),	Frad(2,2),	...,	Frad(6,2),
	Fdif(1,2),	Fdif(2,2),	...,	Frad(6,2),
	FK(1,2),	FK(2,2),	...,	FK(6,2),
	Fres(1,2),	Fres(2,2),	...,	Fres(6,2),
	Fdmp(1,2),	Fdmp(2,2),	...,	Fdmp(6,2),
	Fslam(1,2),	Fslam(2,2),	...,	Fslam(6,2)

n-1	Time (step=n-1)			
	Ftot(1,n-1),	Ftot(2,n-1),	...,	Ftot(6,n-1),
	Frad(1,n-1),	Frad(2,n-1),	...,	Frad(6,n-1),
	Fdif(1,n-1),	Fdif(2,n-1),	...,	Frad(6,n-1),
	FK(1,n-1),	FK(2,n-1),	...,	FK(6,n-1),
	Fres(1,n-1),	Fres(2,n-1),	...,	Fres(6,n-1),
	Fdmp(1,n-1),	Fdmp(2,n-1),	...,	Fdmp(6,n-1),
	Fslam(1,n-1),	Fslam(2,n-1),	...,	Fslam(6,n-1)
n	Time (step=n)			
	Ftot(1,n),	Ftot(2,n),	...,	Ftot(6,n),
	Frad(1,n),	Frad(2,n),	...,	Frad(6,n),
	Fdif(1,n),	Fdif(2,n),	...,	Frad(6,n),
	FK(1,n),	FK(2,n),	...,	FK(6,n),
	Fres(1,n),	Fres(2,n),	...,	Fres(6,n),
	Fdmp(1,n),	Fdmp(2,n),	...,	Fdmp(6,n),
	Fslam(1,n),	Fslam(2,n),	...,	Fslam(6,n)

Where n is the total number of time steps (=numstep/10).

5.6 <FILENAME>.MOTION

This file contains ship motions at each time step. The output ship motions are nondimensionalized as follows:

$$X_i (i = 1, 2, 3): \quad X_i / A$$

$$X_i (i = 4, 5, 6): \quad X_i / kA$$

where $X_i (i = 1, 2, 3, 4, 5, 6)$ are the displacements of ship motions corresponding to surge, sway, heave, roll, pitch and yaw, respectively; The symbol, A , denotes the wave amplitude and k is the wave number.

Time	Displacements of ship motions in six modes at each time step					
t(1)	$X_1(1)$	$X_2(1)$	$X_3(1)$	$X_4(1)$	$X_5(1)$	$X_6(1)$
t(2)	$X_1(2)$	$X_2(2)$	$X_3(2)$	$X_4(2)$	$X_5(2)$	$X_6(2)$
	...	...	...	...	...	...
t(numstep)	$X_1(\text{numstep})$	$X_2(\text{numstep})$	$X_3(\text{numstep})$	$X_4(\text{numstep})$	$X_5(\text{numstep})$	$X_6(\text{numstep})$

where numstep is the total number of time step.

5.7 <FILENAME>.VEL

This file contains the velocities of ship motions at each time step.

Time	Velocities of ship motions in six modes at each time step					
t(1)	vel(1,1)	vel(2,1)	vel(3,1)	vel(4,1)	vel(5,1)	vel(6,1)
t(2)	vel(1,2)	vel(2,2)	vel(3,2)	vel(4,2)	vel(5,2)	vel(6,2)

```

...           ...           ...           ...           ...
t(numstep)    vel(1,numstep) vel(2,numstep) vel(3,numstep) vel(4,numstep)
               vel(5,numstep) vel(6,numstep)

```

where numstep is the total number of time step.

5.8 <FILENAME>.ACC

This file contains the acceleration of ship motions in six degrees of freedom at each time step

```

Time           Accelerations of ship motions in six modes at each time step
t(1)           acc(1,1) acc(2,1) acc(3,1) acc(4,1) acc(5,1) acc(6,1)
t(2)           acc(1,2) acc(2,2) acc(3,2) acc(4,2) acc(5,2) acc(6,2)
...           ...           ...           ...           ...           ...
t(numstep)     acc(1,numstep) acc(2,numstep) acc(3,numstep) acc(4,numstep)
               acc(5,numstep) acc(6,numstep)

```

where numstep is the total number of time step.

5.9 <FILENAME>.FX

This file contains the sea loads acting on a cross-section at each time step. If sealoactr=0, the file won't be produced. The output sea loads are nondimensionalized as described in Section 5.1.

```

Time           Sea loads in six modes at each time step
t(1)           fx(1,1) fx(2,1) fx(3,1) fx(4,1) fx(5,1) fx(6,1)
t(2)           fx(1,2) fx(2,2) fx(3,2) fx(4,2) fx(5,2) fx(6,2)
...           ...           ...           ...           ...           ...
t(numstep)     fx(1,numstep) fx(2,numstep) fx(3,numstep) fx(4,numstep)

```

$$fx(5,numstep) \quad fx(6,numstep)$$

where numstep is the total number of time step.

5.5 <FILENAME>.PRES

This file contains the pressure distribution on hull at each time step. If presctr=0, this file won't be produced.

The pressure is nondimensionalized as follows:

$$P: \quad P / \rho g A$$

Where P , ρ , g and A denote the pressure, water density, acceleration due to gravity and wave amplitude, respectively.

If **outpres = 1**, pressures on points as input in <filename>.presxyz will be output in the following format:

Time	Pressures at each time step			
t(1)	pres(1,1)	pres(2,1)	... pres(numpres-1,1)	pres(numpres,1)
t(2)	pres(1,2)	pres(2,2)	... pres(numpres-1,2)	pres(numpres,2)
...	..	...	...	...
t(numstep)	pres(1,numstep)	pres(2,numstep)	... pres(numpres-1,numstep)	pres(numpres,numstep)

where n is the total number of time step and numpres is the number of points.

If **outpres = 2**, pressures on centroids of panels in both port and starboard will be output in the following format:

Time	Pressure distributions over panels at each time step				
t(1)	pres(1,1)	pres(2,1)	...	pres(npanel-1,1)	pres(npanel,1) (port)
	pres(1,1)	pres(2,1)	...	pres(npanel-1,1)	pres(npanel,1) (starboard)
t(2)	pres(1,2)	pres(2,2)	...	pres(npanel-1,2)	pres(npanel,2) (port)
	pres(1,2)	pres(2,2)	...	pres(npanel-1,2)	pres(npanel,2) (starboard)
...	...	...	...	...	...
t(numstep)	pres(1,numstep)	pres(2,numstep)	...	pres(npanel-1,numstep)	
	pres(npanel,n) (port)				
	pres(1,numstep)	pres(2,numstep)	...	pres(npanel-1,numstep)	
	pres(npanel,numstep) (starboard)				

where npanel is the total number of panels under waterline in both port and starboard.

REFERENCES

- [1] Holtrop, J. and Mennen, G., "An approximate power prediction method", *International Shipbuilding Progress*, Vol. 29, No. 335, July 1982.
- [2] Kijima, K., Katsuno, T., Nakiri, Y. and Furukawa, Y., "On the maneuvering performance of a ship with the parameter of loading condition", *Journal of the Society of Naval Architects of Japan*, Vol. 168, pp.141-148, 1990.

APPENDIX I RESISTANCE COMPUTATION

The resistance is important to surge, sway and yaw in the time-domain simulation. If the resistance model test data are available, the resistance can be interpolated at the prescribed speed. If there are no test data available, empirical formulae, given by Holtrop and Mennen (1982) [1], can be used as resistance estimation for a generic hull form.

For a specific hull form, the user can input the empirical formulae by changing the code.

APPENDIX II CROSS-FLOW DRAG COMPUTATION

The cross-flow drag affects the surge, sway and yaw motions. If there is a measured cross-flow drag available, the cross-flow drag will be interpolated at the relative velocity between the hull and the water particle of the local cross-flow.

The cross-flow drag and moment can also be estimated from the cross-section geometry as follows:

$$F_2^{cross} = -\frac{1}{2} \rho \int_0^{L_{pp}} C_d(x) T(x) v_2(x, t) |v_2(x, t)| dx \quad (II-1)$$

$$F_6^{cross} = -\frac{1}{2} \rho \int_0^{L_{pp}} x C_d(x) T(x) v_2(x, t) |v_2(x, t)| dx \quad (II-2)$$

where $C_d(x)$ is the sectional cross-flow coefficient (≈ 1.5); $T(x)$ is the local draft of the ship at section x ; L_{pp} is the ship's length between perpendiculars; and $v_2(x, t)$ is the transverse relative velocity between the hull and the water particles of the local cross-flow.

APPENDIX III PROPELLER THRUST COMPUTATION

The thrust and torque of the propeller can be estimated from the available $K_T - K_Q - J$ charts of a standard propeller series as follows:

$$F_t^{prop} = (1 - t_p) \rho n_p^2 D_p^4 K_T(J) \quad (\text{III-1})$$

$$F_s^{prop} = \rho n_p^2 D_p^5 K_Q(J) \quad (\text{III-2})$$

$$J = \frac{U(1 - w)}{n_p D_p} \quad (\text{III-3})$$

where t_p and w are the thrust deduction fraction and wake fraction, respectively; n_p is the number of revolutions per second of the propeller; D_p is the propeller diameter; U is the forward speed of the ship; J is the advancing ratio; K_T and K_Q are the thrust coefficient and the torque coefficient, respectively.

APPENDIX IV MANEUVERING FORCE COMPUTATION

The following nonlinear lateral force and turning moment are adopted in the seakeeping simulation [2]:

$$F_2^{maneu}(t) = \frac{1}{2} \rho L_{pp} T \bar{U}^2 (Y_{\beta} \beta' + Y_{\gamma} \gamma' + Y_{\beta\beta} |\beta'| \beta' + Y_{\gamma\gamma} |\gamma'| \gamma' + (Y_{\beta\beta\gamma} \beta' + Y_{\beta\gamma\gamma}) \beta' \gamma') \quad (\text{IV-1})$$

$$F_6^{maneu}(t) = \frac{1}{2} \rho L_{pp}^2 T \bar{U}^2 (N_{\beta} \beta' + N_{\gamma} \gamma' + N_{\beta\beta} |\beta'| \beta' + N_{\gamma\gamma} |\gamma'| \gamma' + (N_{\beta\beta\gamma} \beta' + N_{\beta\gamma\gamma}) \beta' \gamma') \quad (\text{IV-2})$$

where L_{pp} is the ship length; T is the ship draft; $\beta' = -u_2 / \bar{U}$ and $\gamma' = u_6 L_{pp} / \bar{U}$; $\bar{U}$ is the instantaneous forward velocity (i.e., the forward speed of ship plus the surge velocity); u_2 and u_6 are the instantaneous sway and yaw velocities, respectively. The hydrodynamic derivatives Y 's and N 's can be determined from empirical formulae or using test data.

In SEALOAD, we define

$y\text{coeff}(1) = Y_{\beta}$	$n\text{coeff}(1) = N_{\beta}$
$y\text{coeff}(2) = Y_{\gamma}$	$n\text{coeff}(2) = N_{\gamma}$
$y\text{coeff}(3) = Y_{\beta\beta}$	$n\text{coeff}(3) = N_{\beta\beta}$
$y\text{coeff}(4) = Y_{\gamma\gamma}$	$n\text{coeff}(4) = N_{\gamma\gamma}$
$y\text{coeff}(5) = Y_{\beta\beta\gamma}$	$n\text{coeff}(5) = N_{\beta\beta\gamma}$
$y\text{coeff}(6) = Y_{\beta\gamma\gamma}$	$n\text{coeff}(6) = N_{\beta\gamma\gamma}$

These coefficients can be estimated as follows [2] if no test data are available:

$$Y_{\beta} = \frac{1}{2}\pi k + 1.4C_b B / L_{pp} \quad (\text{IV-3})$$

$$Y_{\gamma} = -1.5C_b B / L_{pp} + m' + m'_x \quad (\text{IV-4})$$

$$Y_{\beta\beta} = 2.5T(1 - C_b) / B + 0.5 \quad (\text{IV-5})$$

$$Y_{\gamma\gamma} = 0.343TC_b / B - 0.07 \quad (\text{IV-6})$$

$$Y_{\beta\gamma\gamma} = 5.95T(1 - C_b) / B \quad (\text{IV-7})$$

$$Y_{\beta\beta\gamma} = 1.5TC_b / B - 0.65 \quad (\text{IV-8})$$

$$N_{\beta} = k \quad (\text{IV-9})$$

$$N_{\gamma} = -0.54k + k^2 \quad (\text{IV-10})$$

$$N_{\beta\beta} = -0.96T(1 - C_b) / B + 0.066 \quad (\text{IV-11})$$

$$N_{\gamma\gamma} = 0.5C_b B / L_{pp} - 0.09 \quad (\text{IV-12})$$

$$N_{\beta\gamma\gamma} = -(0.5TC_b / B - 0.05) \quad (\text{IV-13})$$

$$N_{\beta\beta\gamma} = -[57.5(C_b B / L_{pp})^2 - 18.4C_b B / L_{pp} + 1.6] \quad (\text{IV-14})$$

where

$$k = 2T / L_{pp} \quad (\text{IV-15})$$

$$m' = m / (0.5\rho L_{pp}^2 T) \quad (\text{IV-16})$$

$$m'_x = 2.7m^{5/3} / L_{pp}^2 / (0.5\rho L_{pp}^2 T) \quad (\text{IV-17})$$

L_{pp} , B , T , and C_b are the ship length between perpendiculars, beam, draft and block coefficient, respectively. m and m_x are the ship's mass and the added-mass in the x -direction, respectively.

APPENDIX V RUDDER FORCE COMPUTATION

According to [2], the normal force acting on the rudder can be estimated by:

$$F_N = -\frac{1}{2} \rho \frac{6.13\lambda}{\lambda + 2.25} A_R V_R^2 \sin \alpha_e \quad (V-1)$$

where λ is the aspect ratio of the rudder; A_R is the rudder planform area; V_R is the velocity of a water particle relative to the rudder; ρ is the water density and α_e is the effective rudder angle:

$$\alpha_e = \alpha + \tan^{-1} \left(\frac{u_2 - d_z u_6 + d_z u_4}{(1-w)U + u_1} \right) \quad (V-2)$$

where α is the rudder angle defined as positive angle when it is turned to the port side; U is the ship forward speed; w is the wake fraction; d_x and d_z are the horizontal and vertical distances between the rudder's center of pressure and the center of gravity of ship, respectively; u_i ($i=1,2,3,4,5,6$) denote the velocities of ship motions. The components of rudder force can be obtained as follows:

$$F_1^{RUD} = -|F_N| \sin \alpha \quad (V-3)$$

$$F_2^{RUD} = F_N \cos \alpha \quad (V-4)$$

$$F_4^{RUD} = d_z F_N \cos \alpha \quad (V-5)$$

$$F_5^{RUD} = -d_x F_N \cos \alpha \quad (V-6)$$

For the course-keeping purposes, the following auto-pilot can be used:

$$\alpha(t) = \begin{cases} \alpha'_1 s_\delta + \alpha'_2 \dot{s}_\delta & \text{if } s_\delta > \alpha_0 \\ 0 & \text{if } s_\delta \leq \alpha_0 \end{cases} \quad (\text{V-7})$$

where α'_1 and α'_2 denote the yaw gain and the yaw rate gain, respectively; s_δ is the yaw angle; and α_0 is the threshold value of yaw beyond which the rudder is activated.

APPENDIX VI CPF.OTHERF

this file deals with the rudder force, maneuvering force,
cross flow force, propulsion force and resistance.

control data for the input forces

```
&inputforcecontrol
resisctr = 0
crossctr = 0
propctr = 0
maneuctr = 0
rudderctr = 0
/
```

resistance data

```
&resisdata
numdata =
uspeed, resistance =
/endresisdata
```

cross flow

```
&crossflow
numcross =
crossspeed =
crossdrag =
/endcrossflow
```

cross-sectional geometry

```
&crosssection
nsection=22
xcross = -62.2000
-61.7000
-59.3750
-56.2500
-50.0000
-43.7500
-37.5000
-31.2500
-25.0000
-18.7500
-12.5000
-6.2500
0.0000
6.2500
12.5000
18.7500
25.0000
31.2500
37.5000
43.7500
-62.2000
-61.7000
-59.3750
-56.2500
-50.0000
-43.7500
-37.5000
-31.2500
-25.0000
-18.7500
-12.5000
-6.2500
```

[illegible]

```
&prophd
numkt =
kt =
kq =
jt =
/endprophd

# maneuvering coefficients

&manuver
ycoeff =
ncoeff =
/endmanver

# rudder geometry

&ruddergeo
gap = 5.0
rudwidth = 3.415
aspectratio = 1.552
xrudc = 59.291
zrudc = 4.515
rudarea = 19.00
/endorruddergeo

# Autopilot information

&autopilot
bias = 0.0
gainangle = 1.0
gainrate = 0.0
threshold = 0.0
rudlim = 35.0
/endautopilot
```

APPENDIX VII CPF.PRESXYZ

8
56.025 0.7 -1.97
56.025 0.0 -4.97
43.575 0.0 -4.97
38.595 0.0 -3.22
17.430 0.0 -4.97
3.1125 0.0 -4.97
-18.675 0.0 -4.97
-52.9125 0.0 -1.67

APPENDIX VIII CPF.HULL

4816	4527			
1	60.17500	0.00000	-2.96049	
2	60.17500	0.00000	-2.94049	
3	60.17500	0.00000	-2.94049	
4	60.17500	0.00000	-2.94049	
5	60.17502	0.00000	-2.94046	
...	...	...	...	...
1	1	21	22	23
2	2	24	25	26
...	...	...	...	...

cpf.wave

0.0000	0.0000
0.0200	0.0027
0.0400	0.0054
0.0600	0.0081
0.0800	0.0108
0.1000	0.0135
0.1200	0.0161
0.1400	0.0187
0.1600	0.0213
0.1800	0.0239
0.2000	0.0265
0.2200	0.0290
0.2400	0.0315
0.2600	0.0340
0.2800	0.0364
0.3000	0.0388

APPENDIX IX CPF.MOTION

0.4000E-01	0.4680E-05	-0.1086E-09	-0.3303E-05	0.1765E-09	0.1019E-04	0.8613E-10
0.6000E-01	0.1390E-04	0.2504E-09	-0.1027E-04	0.5847E-09	0.3015E-04	-0.6013E-10
0.8000E-01	0.2753E-04	0.4617E-09	-0.2127E-04	0.3220E-09	0.5946E-04	0.9021E-12
0.1000E+00	0.4543E-04	0.1809E-09	-0.3667E-04	0.3370E-09	0.9771E-04	0.2649E-09
0.1200E+00	0.6745E-04	-0.1220E-09	-0.5686E-04	-0.1432E-09	0.1445E-03	0.3663E-09
0.1400E+00	0.9346E-04	-0.5421E-09	-0.8221E-04	0.2525E-09	0.1993E-03	0.6217E-09
0.1600E+00	0.1233E-03	-0.8130E-09	-0.1131E-03	0.1012E-08	0.2619E-03	0.4348E-09
0.1800E+00	0.1569E-03	-0.1161E-08	-0.1499E-03	0.2092E-08	0.3317E-03	0.7410E-10
0.2000E+00	0.1940E-03	-0.1526E-08	-0.1931E-03	0.2936E-08	0.4085E-03	-0.3162E-09

APPENDIX X CPF.FX

0.4000E-01	-0.5026E-01	-0.1298E-04	-0.2842E+01	0.3748E-05	0.2619E+02	-0.3595E-04
0.6000E-01	-0.5019E-01	-0.1160E-04	-0.2870E+01	0.7036E-06	0.2627E+02	-0.3969E-04
0.8000E-01	-0.5013E-01	0.1452E-04	-0.2898E+01	-0.2690E-05	0.2636E+02	0.4119E-04
0.1000E+00	-0.5007E-01	-0.8319E-05	-0.2926E+01	0.5745E-08	0.2644E+02	0.7857E-04
0.1200E+00	-0.5000E-01	0.8440E-06	-0.2954E+01	0.2448E-07	0.2653E+02	-0.3765E-04
0.1400E+00	-0.4994E-01	-0.3701E-05	-0.2982E+01	0.6278E-06	0.2661E+02	0.2711E-04

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The computer program SEALOADS version 1.1 is able to predict the nonlinear ship motions as well as hydrodynamic pressure distribution and sea loads on the hull in the time-domain. The program consists of four independent sub-programs: RAD to compute the response function due to radiated waves; DIF to compute the response function due to diffracted waves; DAMP to compute the roll damping coefficients; and SEALOAD, the main program, to compute the ship motions, pressures and sea loads.

This manual describes the installation and operation of SEALOADS version 1.1 on a FreeBSD UNIX system. The structures of input and output data files are described, and example files are also illustrated in this manual.

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